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The effectiveness of microteaching techniques for improving presentation of science demonstrations by perspective science teachers was investigated. Three groups of students of ten members each were randomly selected from professional education courses for science teachers. Group A students presented two trials of two different demonstrations. Each presentation was video-taped and replayed immediately for the student making the presentation. Students in the micro-class verbally critiqued each presentation, evaluation it by means of an instrument developed for the study. Group B students were participants in four or more classes but did not perform demonstrations. Those in Group C were not involved in the microteaching experiences. The following quarter each student in Groups A, B, and C were evaluated while presenting demonstrations to classes in their secondary school practice teaching assignments. Results showed more increase in effectiveness between the first and second trials of the second demonstration than between the first and second trials of the first demonstration in the micro-class. It was also concluded that students who were members of the micro-classes presented better demonstrations when teaching than those who taught micro-classes. (DH)

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A STUDY OF MICRO-TEACHING IN THE PRESERVICE EDUCATION OF SCIENCE TEACHERS

ABSTRACT OF
DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By

Daniel Thaddeus Goldthwaite, B.S., M.Ed.

* * * * * *

The Ohio State University
1968

Approved by

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Adviser
College of Education

A STUDY OF MICRO-TEACHING IN THE PRESERVICE EDUCATION OF SCIENCE TEACHERS

By

Daniel Thaddeus Goldthwaite, Ph.D.

The Ohio State University, 1968

Professor Fred R. Schlessinger, Adviser

Micro-teaching was defined as a scaled-down model of teaching in which prospective secondary school science teachers presented short demonstrations to micro-classes composed of four peers.

The objectives of the study were to determine if presenting science demonstrations on a teach-reteach basis would result in immediate improvement in effectiveness, and if student teachers who had participated in the micro-teaching experience would present demonstrations more effectively than those who had not participated.

The three groups of students (ten in each) who participated in the study were randomly selected from Laboratory Practicums for prospective science teachers at The Ohio State University. Each student in Group A presented two trials of two different demonstrations. The two trials of each demonstration were presented the same day. The two demonstrations were approximately three weeks apart. Each trial was recorded on video tape and replayed immediately for the student who had made the presentation. The students in the micro-classes verbally

critiqued each presentation and evaluated it using a Demonstration Evaluation Form developed by the investigator.

Each person in Group B participated as a student in four or more micro-classes. Additional students from the practicums participated as members of the micro-classes. The students in Group C did not participate in the micro-teaching experience.

During student teaching the following quarter each student in Groups A, B, and C presented a demonstration to his secondary school science class. Each presentation was evaluated by three persons using a slightly modified version of the evaluation form used previously. The evaluation form consisted of ten questions based on the criteria of an effective demonstration with five choices of answers ranging from unsatisfactory (one) to very superior (five). All statistical tests were based on the total scores of the forms and were made at the 0.05 level.

The study tested three hypotheses. The first hypothesis was that during the micro-teaching sessions there would be no significant difference with which each student would present: the first and second trials of each demonstration; or the second trial of the first demonstration compared to the second trial of the second demonstration. Based on a t-test between the first and second trials of the twenty demonstrations, the first part of this hypothesis was not rejected. Based on a similar test, the second part of the hypothesis was rejected.

The second hypothesis was that there would be no significant difference in the effectiveness with which student teachers in Groups A, B, and C would present demonstrations to their secondary school science classes. Based on the results of an analysis of covariance study this hypothesis was rejected.

The third hypothesis, that there would be no significant difference in the effectiveness with which the fifteen most dogmatic and the fifteen least dogmatic student teachers would present demonstrations, was tested and was not rejected.

It was concluded that since the micro-teaching technique resulted in a greater increase in effectiveness between the first and second trials of the second demonstration than between the first and second trials of the first demonstration, its value increases with each demonstration presented. It was also concluded that the micro-teaching technique was apparently more beneficial to the students who were members of the micro-classes than to the students who presented the demonstrations. Finally, it was concluded that the degree to which the student teachers who participated in this study had open or closed minds did not have a significant effect on the effectiveness with which they presented demonstrations to secondary school science classes.

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CHAPTER I

INTRODUCTION

Starting in 1957 with the introduction of the Physical Science Study Committee (PSSC) and continuing with the Chemical Education Material Study (CHEMS), the Chemical Bond Approach (CBA), the Biological Sciences Curriculum Study (BSCS), the Earth Science Curriculum Project (ESCP), and Introductory Physical Science (IPS), there has been a trend in the secondary school away from the teacher-centered classroom and teacher demonstrations, toward a student-centered classroom and student experiments. Each of these course content improvement projects emphasizes the value of the student's active participation in the laboratory to make secondary science a process of discovery. By stressing the development of science concepts through laboratory investigations it is desired to give the science classroom the atmosphere of a true science research laboratory. This is expected to give the student a better concept of science and increase his interest in science as a subject.

However, this rejection of teacher demonstrations by the course content improvement projects does not indicate that demonstrations are no longer an effective teaching technique. There is no evidence which indicates that the new courses are the best way to teach science. There is no conclusive evidence to prove that individual student experiments are a more effective teaching technique than teacher demonstrations or vice versa.

This issue is not one which has developed recently. To trace its origin it is necessary to review briefly the history of science teaching in the public schools. Although some sciences were taught in the academies, it was not until the public high schools were formed early in the nineteenth century that chemistry and physics were taught. Biology as a high school subject did not appear until after the turn of the twentieth century. Woodburn and Obourn described the teaching of science in the early high schools as being conducted largely for informational and practical values. Science teaching then involved a very limited amount of demonstration and practically no laboratory work. Reports indicate that although seemingly popular, science courses were taken largely by those students not going on to college. The courses were taught mainly by lecture and recitation, and the memorization of facts was emphasized.[1]

Teacher demonstrations remained the dominant technique until the Harvard Descriptive List was published in 1887, approximately the time that physics became a required course for college entrance. The Harvard Descriptive List contained forty-six physics experiments to be completed by students before entering college. As a guide to teachers, specific directions were given for conducting the experiments. At a time when only a small number of high schools had adequate laboratory facilities and there were only a few qualified physics teachers, the Harvard

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[1] John H. Woodburn and Ellsworth S. Obourn, Teaching the Pursuit of Science (New York: The MacMillan Company, 1965), p. 170.

Descriptive List became an important influence on physics teaching. Woodburn and Obourn, in summarizing the effects of the Harvard Descriptive List, stated: "There can be little doubt that the widespread use of laboratory work in physics courses can be traced directly to the influence of the Harvard Descriptive List."[2]

However, at approximately the same time that the use of laboratory work was rapidly increasing, the number of high school students was also growing. In a review of research Curtis described the prevailing conditions in secondary school science teaching at the end of the nineteenth century. He stated that as long as the number of students enrolled in science courses remained relatively small, individual student experiments were a very satisfactory teaching technique. However, as the number of students rapidly increased and the expense of laboratory facilities and equipment also increased, there was a trend toward more teacher demonstration, especially in the introductory courses.[3]

Studies were made to determine if either individual laboratory experiments or teacher demonstrations were more effective than the other. Results of the early studies were interpreted to indicate that the demonstration technique was at least as effective as the experimental technique. This was a boon to an educational system attempting to provide a secondary school education to a rapidly increasing school population. As a result some large city high schools were built with no provisions for individual student laboratory work.

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[2] Ibid., p. 184.

[3] Francis D. Curtis, "Some Contributions of Educational Research to the Solution of Teaching Problems in the Science Laboratory," A Program for Teaching Science, Thirty-first Yearbook of the National Society for the Study of Education, Part I (Chicago: The University of Chicago Press, 1932), p. 97.

However, as time passed weaknesses of the early studies were revealed. According to Curtis:

> (1) the experimental and statistical techniques employed were to a considerable extent faulty and inadequate; and (2) the lack of reliable and valid objective tests for measuring instructional outcomes other than retention of subject-matter knowledge rendered the results in the main unconvincing.[4]

After additional studies had been conducted, Curtis summarized the results as follows. There was supporting evidence to indicate that both teacher demonstrations and student experiments are valuable teaching techniques. Advantages of teacher demonstrations include economy of both time and money. Less equipment is needed for teacher demonstrations, and more complex apparatus can be used by the teacher, saving the time used to instruct the students in its use. The main advantage of student experiments is the opportunity for students to learn desirable manipulatory skills and laboratory techniques.

Curtis recommended that teachers do many demonstrations at the beginning of each course to teach students experimental procedures and use of the apparatus. He also recommended that teachers use more demonstrations than student experiments with classes of younger or less capable students, especially when the experiments might be dangerous when performed by these students.

It was also recommended that the time saved by doing demonstrations be used to enrich the program with other teaching techniques such as reading projects, individual investigations, observations, and drill upon essentials.[5]

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[4] Ibid., p. 98.

A committee discussing issues in the Forty-sixth Yearbook endorsed the summary by Curtis in the Thirty-first Yearbook with only minor modifications. The committee no longer stressed the importance of teacher demonstrations for younger or less capable students. Neither did they feel it necessary to repeat the recommendation that teachers do demonstrations at times when the experiment might be dangerous for students.[6]

Although the controversy had not died, the Fifty-ninth Yearbook did not devote much space to it. In the chapter titled Status of Science Teaching the committee wrote:

> Numerous studies have attempted to determine the relative merit of the individual laboratory and the lecture-demonstration method of teaching science. Both methods have merit. Traditional biology, chemistry, and physics make extensive use of laboratory work. More demonstration than laboratory work is carried on in the general science courses. The directed type of laboratory exercise is apparently giving ground to the investigative type.[7]

Recent research has not resolved the issue of demonstration versus individual student experiments. In 1964 Bailey compared the effectiveness of an enriched lecture-demonstration method and the laboratory method as techniques for teaching eleventh grade physical science. He used the Anderson Chemistry Test at the beginning and the conclusion of the course to measure academic achievement. Bailey stated that the results of his study indicated that individual laboratory work had not produced a significantly higher mastery of scientific concepts as measured by a standardized test than had the enriched lecture-demonstration method. He added that the group taught with demonstrations made higher scores on the Anderson Chemistry Test than the group who were taught by the laboratory method. This higher achievement was particularly significant among students with less than average ability. However, the study did not produce evidence in favor of laboratory work in the eleventh grade physical science class.

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[5] Ibid., pp. 105-106.

[6] National Society for the Study of Education, Science Education in American Schools, Forty-sixth Yearbook, Part I (Chicago: The University of Chicago Press, 1947), pp. 53-54.

[7] Robert Stollberg et al., "The Status of Science-Teaching in Elementary and Secondary Schools," Rethinking Science Education, Fifty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: The University of Chicago Press, 1960), pp. 88-89.

Based on the high achievement of the low ability groups, Bailey recommended that senior physical science be taught on a full time basis using the enriched lecture-demonstration method. He claimed that it would be more economical than a laboratory-centered course and at the same time give more students an opportunity to take more science.[8]

In 1965 Coulter compared the effectiveness of three teaching techniques for high school biology. The three techniques were inductive laboratory, inductive demonstration, and deductive laboratory. Using the results of a pre and post administration of locally made instruments he concluded that, in general, the inductive approaches--both laboratory and demonstration--to teaching a required course in biology were as effective as the deductive approach in regard to the teaching of facts, application of principles, and laboratory techniques.

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[8] Orris Glenn Bailey, "A Comparison of Achievement in the Concepts of Fundamentals of Eleventh-Grade Senior Physical Science Students Taught by Laboratory Versus Enriched Lecture-Demonstration Methods" (unpublished Ed.D. dissertation, University of Houston, 1964), pp. 82-84.

Coulter also reported that none of the three methods appeared to be more effective for any one ability group. He added that there was some evidence to indicate that the inductive methods were more effective in teaching the aspects of scientific inquiry.[9]

In 1966 Sorensen compared the change in critical thinking ability of high school biology students who had been taught by either the laboratory centered or lecture-demonstration technique. Sorensen used the Cornell Test of Critical Thinking and the Watson-Glaser Critical Thinking Appraisal to measure the student's critical thinking skills. Each student was also given the Test on Understanding Science.

Among the conclusions reached by Sorensen was that the laboratory-centered method of teaching caused greater changes in the critical thinking ability of students than did the lecture-demonstration-centered method of teaching. There was a significant change in understanding science for the laboratory-centered group, but not for the demonstration-centered group. There was also evidence which indicated that there was no relationship between mental ability and changes in critical thinking ability.[10]

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[9] John Chester Coulter, "The Effectiveness of Inductive Laboratory, Inductive Demonstration, and Deductive Laboratory Instruction in Biology" (unpublished Ph.D. dissertation, University of Minnesota, 1965), pp. 133-134.

[10] LaVar Leonard Sorensen, "Change in Critical Thinking Between Laboratory Centered and Lecture-Demonstration-Centered Patterns of Instruction in High School Biology" (unpublished Ed.D. dissertation, Oregon State University, 1966), pp. 122-124.

At the college level Ricker compared four methods of presenting basic properties of magnetism. The four methods were: (A) lecture only, (B) lecture and teacher demonstration, (C) lecture and student experiment, and (D) lecture and programmed learning. Ricker constructed tests to measure the student's ability to relate his knowledge of information about magnetism. He concluded: "if the desired outcome of the course is the accumulation of facts and principles then Method A (lecture only) is superior in reference to the other three experimental methods."[11]

None of these studies has proved that either individual student experiments or teacher demonstrations are the better teaching technique. If they indicate anything, it is that both techniques are effective when properly used, and that each has an important function in the teaching of science.

Professional Education

To prepare prospective science teachers to use demonstrations more effectively, there are professional education courses. There are four such courses taught at The Ohio State University. In each of these the term demonstration is judged important enough to be included in the course description.

At the present time all prospective secondary school science teachers at The Ohio State University are required to take Education 551 (Science in Secondary Schools). Depending on their major or minor teaching area they also take one or more of the Education 625 (Practicum in Biological Science for Teachers), Education 626 (Practicum in the Earth Sciences for Teachers), Education 627 (Practicum in General and Physical Science for Teachers) series.[12] In all of these courses demonstrations are one of the important topics covered. The teacher usually presents demonstrations to the class and leads a discussion on the advantages, limitations, and criteria for effective demonstrations. It is common to have students in the class present demonstrations which are then evaluated by the class according to the criteria discussed earlier. Although this type of demonstration has a tendency to be artificial, it appears to be at the present time, the only substitute for a presentation to a secondary school class in a public school or a campus laboratory school.

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[11] Phillip Edwin Ricker, "An Experimental Comparison of Four Methods of Presenting Basic Properties of Magnetism" (unpublished Ed.D. dissertation, Colorado State College, 1965), p. 69.

However, this experience with demonstrations does not seem to be sufficient. Observations of student teachers and conferences with cooperating teachers over a period of two years have led the investigator to the following tentative conclusions: in general, student teachers are not as proficient at presenting demonstrations as they should be; and they miss many opportunities to do demonstrations when the need appears in the middle of a class. Lack of experience seems to be a point in both cases. Although inadequate planning appears to be the main reason for inefficient demonstrations, it remains for the research to show if this is a fact or just an assumption.

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[12] See Appendix A.

Problem

The problem selected for this project was to determine if micro-teaching can be utilized within the present structure of science methods classes at The Ohio State University (or other universities with similar preservice programs for science teachers) to improve the effectiveness of demonstrations presented by student teachers. Sub-problems will consider the effects that factors other than the micro-teaching experience (e.g., the student's grade point average in science, or all-college grade point average) might have on the student teacher's classroom performance.

Definitions

Micro-teaching: a scaled-down model of teaching in which a prospective science teacher presents a ten to twenty-five minute demonstration to a micro-class.

Micro-class: the peer group of four students selected from the laboratory practicum who evaluated each demonstration.

Effective presentation of demonstrations: the effectiveness of the presentation was measured using the demonstration evaluation form.[13] The same basic form with slight modifications was used in the micro-classes and during student teaching in the secondary schools.

Objectives

1. The study was designed to determine by classroom observation if student teachers who have had micro-teaching experience in their preservice science methods classes (Group A) present demonstrations

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[13] See Appendix B.

more effectively than student teachers who have participated in the micro-teaching as members of a peer group micro-class (Group B).

2. The study was designed to determine by classroom observation if the student teachers in Group A and Group B present demonstrations more effectively than student teachers who have had no contact with micro-teaching (Group C).

3. The study was designed to determine to what extent the student teacher's classroom performance is influenced by such uncontrolled variables as his grade-point average in science, his overall college grade-point average, and his rating on the Rokeach Dogmatism Scale.

4. The study was designed to determine if there is any relationship between how effectively a student teacher presents demonstrations and his rating on the Rokeach Dogmatism Scale, Scale E.[14]

5. The study was designed to determine the reliability of the demonstration evaluation instrument used in the study.

6. The investigator measured and recorded the progress of each student in Group A during his micro-teaching experience to determine if there were any patterns of improvement between the different trials of the same demonstration or between the different demonstrations.

Hypotheses

The null hypotheses tested were:

1. During the micro-teaching sessions, there would be no significant difference in the effectiveness with which each teacher would present:

---

[14] See Appendix C.

a) the first and second trials of each demonstration.

b) the second trial of the first demonstration and
the second trial of the second demonstration.

2. During part two of the study there would be no significant difference in the effectiveness with which student teachers in Groups A, B, and C would present demonstrations to their secondary school science classes.

3. During part two of the study there would be no significant difference in the effectiveness with which the fifteen most dogmatic student teachers and the fifteen least dogmatic teachers would present demonstrations to their secondary school science classes.

Procedure

Three groups of students participated in the study. Groups A, B, and C each contained ten students: five biological science majors and five physical science majors.

Each student in Group A had completed Education 551 (Science in Secondary Schools), was enrolled in either Education 625 (Practicum in Biological Science for Teachers) or Education 627 (Practicum in General and Physical Science for Teachers) either Autumn Quarter, 1967 or Winter Quarter, 1968, and was enrolled in Education 587.27 (Student Teaching in Secondary Schools) either Winter Quarter, 1968 or Spring Quarter, 1968.

The same criteria which were used to select the students for Group A were used to select the ten students in Group B who would be evaluated during their student teaching experience. Since more than ten students were needed to supply the necessary number of micro-classes, additional students--including graduate students--were selected from the practicums. A majority (eighty per cent) of the micro-classes were composed of one graduate student and three undergraduate students.

Each student in Group A presented two different demonstrations separated by a time interval of approximately three weeks. Each demonstration was presented to two separate micro-classes on the same day on a teach-reteach basis. Each trial of each demonstration was evaluated using the demonstration evaluation form and was verbally critiqued by a micro-class. Each trial of each demonstration was recorded on videotape by the investigator. The tape of each first trial was replayed immediately for the student to help him replan his demonstration before the second trial. Each student in Group A was able to replay both video recordings soon after each demonstration.

Each student in Group B participated in at least four micro-classes. The students in Group C did not participate in this part of the study.

The demonstration evaluation forms were statistically analyzed by the investigator to determine if there was a significant difference in the effectiveness between the two trials of each demonstration or between the first or second demonstration.

The investigator also summarized each of the demonstrations presented during part one of the study.

During part two of the study each student in Groups A, B, and C was enrolled in Student Teaching. As early in the quarter as possible each student teacher presented a demonstration to his secondary school science class. Each of these demonstrations was evaluated by three persons including the investigator.

The Rokeach Dogmatism Scale, Form E, was administered to all students student teaching in secondary school science during Winter Quarter, 1968 or Spring Quarter, 1968.

The grade point average in his major teaching area and the professional grade point average for each student teacher in Groups A, B, and C were recorded the last quarter before the one in which he was student teaching.

These data were used with the appropriate statistical tests to test the stated hypotheses.

Delimitations

1. The population of the study was limited to students in the professional College of Education of The Ohio State University.

2. The population from which Groups A, B, and C were selected was limited to students enrolled in Education 587.27 (Student Teaching in Secondary Schools) either Winter or Spring Quarter, 1968.

3. The population from which Groups A and B were selected was in addition limited to students enrolled in either Education 625 (Practicum in Biological Sciences for Teachers) or Education 627 (Practicum in General and Physical Science for Teachers) Autumn Quarter, 1967 or Winter Quarter, 1968.

4. The choice of demonstrations was limited to those which could be completed in a ten to twenty-five minute time period.

Limitations

1. The presence of the investigator and the video recording equipment undoubtedly had some effect on both the subject and the micro-class. To give the subjects the opportunity to become adjusted to the video equipment the investigator recorded an interview with each subject. The interview was restricted to topics such as the weather, his hometown, the subjects he would like to teach, etc.

2. There was a possibility that a student teacher may have done several demonstrations before the one which was evaluated for the study. To reduce the probability of this, demonstrations were presented and evaluated as soon as was practical Winter and Spring Quarters.

3. The investigator was not able to control the student population of the secondary school classes during part two of the study. Therefore undesirable student behavior was an uncontrolled factor in the evaluations of several presentations.

Assumptions

1. Personality conflicts between students in Groups A and B would not be a major factor in the study.

2. The students in the micro-classes would rate the demonstrations presented by the students in Group A as accurately as they could.

3. The three evaluations of demonstrations presented to the secondary school science classes during part two of the study would provide an adequate basis for ranking the student teachers from most effective to least effective.

Overview of the Study

Chapter I has included a rationale for the study, a statement of the problem, definitions, objectives, hypotheses, and a brief description of the procedure. In Chapter II a review of related literature is presented. A detailed description of the procedure for the study is presented in Chapter III. A detailed summary of the finding of the study is presented in Chapter IV. Chapter V contains the investigator's interpretations of the findings and their implications for science methods courses.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of related literature in this chapter will be developed in three parts. In part one the development of micro-teaching and associated research will be discussed. Part two will cover the literature devoted to the presentation of effective demonstrations. The Rokeach Dogmatism Scale will be discussed in part three.

Micro-Teaching at Stanford

Micro-teaching was developed by the College of Education at Stanford University as a part of an experimental teacher education program supported by the Ford Foundation. The purpose of micro-teaching was to give prospective interns as much practice teaching as possible under controlled conditions before they began their year of internship.

Summer Micro-Teaching Clinic, 1963

The first micro-teaching clinic was held during the Stanford Summer Session, 1963. The trainees were randomly divided into two groups. One group was given the standard pre-internship program including observations of teaching. The other half worked in the micro-teaching clinic.

The total act of teaching was broken down into several specific skills. Examples of these skills are:

> 1. Establishing Set
>
> The term _set_ refers to the establishment of cognitive rapport between pupils and teacher to obtain immediate involvement in the lesson. . . .
>
> 2. Establishing Appropriate Frames of Reference
>
> A student's understanding of the material of a lesson can be increased if it is organized and taught from several appropriate points of view. . . .
>
> 3. Achieving Closure
>
> Closure is complementary to set induction. _Closure_ is attained when the major purposes, principles, and constructs of a lesson, or portion of a lesson, are judged to have been learned so that the student can relate new knowledge to past knowledge. . . .
>
> 4. Using Questions Effectively
>
> The ability to ask provocative, answerable, and appropriate questions, and thus to involve pupils actively, is one of the critical skills in teaching. . . .
>
> 5. Recognizing and Obtaining Attending Behavior
>
> Interns can be trained to become more sensitive to the classroom behavior of pupils. The successful experienced teacher, through visual cues, quickly notes indications of interest or boredom, comprehension or bewilderment. . . .
>
> 6. Control of Participation
>
> Micro-teaching sessions enable interns to analyze the kinds of pupil-teacher interaction which characterize their teaching. . . .
>
> 7. Providing Feedback
>
> The feedback process in the training of teachers may be simply stated as providing "knowledge of results." Questioning, visual cues, informal examination of performance, are immediate sources of feedback. . . .
>
> 8. Employing Reward and Punishments (Reinforcement)
>
> Reinforcing desired pupil behavior through the use of reward and punishment is an integral part of the teacher's role as director of classroom learning. . . .
>
> 9. Setting a Model
>
> The importance of analyzing and imitating model

> behavior is a basic assumption supporting the use of observation in a training program.[1]

The interns participating in the 1963 micro-teaching clinic concentrated on six of these skills. They were: (a) establishing set, (b) achieving closure, (c) recognizing attending behavior, (d) controlling participation, (e) building instructional alternatives, (f) disciplining a class.

Before the training phase of the micro-teaching clinic each intern taught a short diagnostic lesson to a group of five secondary school pupils. All the students who participated as members of micro-classes were hired by Stanford University. These diagnostic lessons were observed by a supervisor and recorded on video-tape.

During the clinic the interns received formal training in each of the preceding six skills. Formal training was followed by the micro-teaching sessions. Many of the lessons were presented on a teach-reteach basis. After the first trial of each lesson had been recorded on video-tape and evaluated by a micro-class, the intern and his supervisor replayed the video recording. Although the supervisor evaluated each session, self-evaluation by the intern was stressed. After a brief period of time in which the intern replanned his lesson, he taught the same lesson to a different micro-class. This lesson was also evaluated by the students in the micro-class.

To evaluate the intern as he progressed from one skill to the next, a specific evaluation form was used for each skill. This evaluation form, called a Teacher Demonstration Rating, was an eight item form with a five point scale. The total ratings found from a summeration of the items on the forms were used for statistical analysis.

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[1] Robert N. Bush and Dwight W. Allen, "Micro-Teaching: Controlled Practice in the Training of Teacher" (unpublished paper presented at the Santa Barbara Conference on Teacher Education of the Ford Foundation, 1964), pp. 1-4.

The students who composed the micro-classes were secondary school students hired by the College of Education to participate in the micro-teaching clinic. Each micro-class was composed of one to five students, usually four, and each micro-class was selected to fit the grade level and content of the lesson to be observed.

Each intern also taught a final lesson at the conclusion of the clinic. This lesson was presented to a class of ten students and lasted fifteen minutes.

The results of this first micro-teaching clinic were based on the evaluations of the micro-classes and the supervisors. It was found that the trainees in the experimental micro-teaching group achieved a higher level of teaching competence than the control group. The experimental group had spent about ten hours a week in training, whereas the control group had spent between twenty and twenty-five hours a week in regular classroom instruction and teacher aid experience. The trainees' performance in the micro-teaching clinic also proved to be a good indication of future performance in the subsequent internship.

It was found that student ratings of teaching performance were more reliable than those of supervisors. Moreover, those trainees who had received student appraisal improved significantly more than the trainees who had been evaluated only by supervisors.

During the micro-teaching clinic there was a significant improvement in the trainees' skill in self evaluation. A major factor contributing to this improvement was thought to be the opportunities the trainees had to observe their teaching performances on video recordings.

Finally, the trainees felt that the micro-teaching clinic had been a very valuable experience. This is a very important result since student acceptance or rejection can have a direct bearing on the success or failure of a study.

Summer Micro-Teaching Clinic, 1964

A second micro-teaching clinic was held during summer, 1964. Since there was no control group this summer the procedure of the clinic was slightly changed. Several different groups were formed, and different treatments were used and compared. During the six-week clinic the Teacher Demonstration Rating was given to each intern a minimum of ten times and a maximum of sixteen times. Results, based on pre and post tests during the clinic and the supervisory reports made during the first month of internship training, were essentially the same as those of the 1963 clinic. One additional result of the 1964 clinic was that the interns had made significant progress in learning how to teach the following specific skills:

> (1) training on set induction, (2) training in closure, (3) training in the control of participation in the classroom, (4) training in the use of frames of reference, (5) training in student observation and control techniques in teach-reteach situations, and (6) training in statement analysis and questioning techniques.[2]

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[2] Dwight W. Allen and Jimmie C. Fortune, "An Analysis of Micro-Teaching: A New Procedure in Teacher Education" (unpublished paper presented at the American Educational Research Convention, 1965), pp. 5-8.

Summer Micro-Teaching Clinic, 1965

In summer, 1965, 140 interns participated in the third micro-teaching clinic. Following a five minute diagnostic lesson, each intern was scheduled to teach two teach-reteach cycles a week for three weeks. One lesson a week was video-taped. Each teach-reteach cycle was organized to include: (1) a five minute lesson taught to a micro-class and observed by a supervisor, (2) a five minute supervisory session, (3) another five minute lesson followed by another supervisory session.

Following a one week break the interns participated in team teaching for three weeks. Groups of two to five interns prepared a twelve day teaching unit which they then took turns teaching in the form of twenty to twenty-five minute lessons.

In addition to the Teacher Demonstration Rating Scale used to rate the interns, the Stanford Teacher Competence Appraisal Guide was used to rate the first and last diagnostic lessons. This guide consists of a "thirteen item, seven-interval, forced-choice scale biased toward superior ratings to eliminate J-curve effects."[3]

The thirteen items on the scale are:

> (1) clarity of aims, (2) appropriateness of aims, (3) organization of the lesson, (4) selection of content, (5) selection of materials, (6) beginning the lesson, (7) clarity of presentation, (8) pacing of the lesson, (9) pupil participation and attention, (10) ending the lesson, (11) teacher-pupil rapport, (12) variety of evaluation procedures, and (13) use of evaluation to improve teaching.[4]

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[3] Dwight W. Allen *et al.*, "Micro-Teaching: A Description" (a collection of documents printed by the School of Education, Stanford University, Stanford, California, 1967), sec. III, p. 9.

[4] *Ibid.*, sec. III, p. 15.

The results of the 1965 micro-teaching clinic tend to agree with the results of the clinics in 1963 and 1964. Teacher interns showed significant improvement in nine of the first twelve appraisal guide items. The teacher interns again confirmed the value of immediate evaluation of lessons, both by supervisors and students.

Summer Micro-Teaching Clinic, 1966

The 1966 micro-teaching clinic concentrated on the following teaching skills:

1. Reinforcement
2. Varying the Stimulus
3. Presentation Skill--Set Induction
4. Presentation Skill--Lecturing and use of A-V
5. Illustrating and Use of Examples
6. Presentation Skill--Closure
7. Student-Initiated Questions.[5]

Although basically the same format as previous years was used for the micro-teaching clinic, two important changes were made.

Results of the 1965 micro-teaching led to dissatisfaction with the Stanford Teacher Competence Appraisal Guide. The Appraisal Guide had been developed to measure the overall effectiveness of a lesson. As a result it was very difficult to correlate items on the Appraisal Guide with the specific techniques of the micro-teaching clinic. The clinic staff decided to construct instruments to evaluate student progress in each of the technical skills. However, a shortage of time prevented the clinic staff from establishing the validity and reliability of the instruments before they were used. Since the Appraisal Guide had been designed to evaluate whole lessons, it was still used to evaluate the initial and final diagnostic lessons.

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[5] Ibid., sec. II, pp. 1-2.

Another important change was in the time schedule for the teach-reteach lessons. Where in previous years the reteach had followed directly after a ten minute lesson and a five minute critique, now a fifteen minute interval of time was given to the intern to replan his lesson before the reteach. The reason for this change was the lack of significant change between the teach and reteach lessons the previous summer. Although the fifteen minutes was added there were mixed results. There was a significant change only when more than one teach-reteach cycle was used with a specific skill.

A summary of the 1966 micro-teaching clinic follows:

> The 1966 micro-teaching experience again proved to be a very valuable one for the interns in the Stanford Teacher Education Program. The best evidence for this are the significant gains shown from the first diagnostic to the final diagnostic of the summer.
>
> 1. Once again the difference between supervisor and student ratings on reteach lessons was demonstrated. Our conclusions from previous micro-teaching clinics were sustained again--that student ratings are probably a more accurate measure of behavior change than the supervisor ratings.
>
> 2. The video-tape recorder plays an important role in the supervisory process in micro-teaching. The staff at Stanford is convinced that the most inefficient use of the video-tape is to replay the entire lesson and just sit and watch it. The supervisor needs to point out the specific things (not more than one or two) on which he wants the intern to focus. He needs to replay small segments to emphasize or clarify certain points. In other words, a training course should be required of the supervisors in order to make the most effective use of the video-tape in the supervisory process.
>
> 3. Although the validity and reliability for the specific evaluative technical skills instruments have not been established, they probably offer more face validity for measuring teaching behavior change on the particular

> skill than does the more global Stanford Teacher Competence Appraisal Guide. . . .[6]

Development of Micro-Teaching

Before investigating micro-teaching at other universities it seems appropriate at this time to review briefly some of the factors leading to the development of micro-teaching at Stanford University.

One of the basic factors was a dissatisfaction with research on teaching. In a review of educational research Gage criticized the present status of research on teaching by stating that although this is a very important area of research it has yielded very few significant results. Moreover, he feels research on teaching has been neglected to the point that it is far behind other areas of educational research.[7]

One of the main unsolved problems of research on teaching has been to develop a criterion of teacher effectiveness. Walker wrote "the lack of an adequate, concrete, objective, universal criterion for teaching ability is thus the primary source of trouble for all who would measure teaching."[8]

It was while looking for a solution to the criterion problem which had been the source of so many problems to researchers on teaching that Gage wrote:

> One solution within the "criterion-of-effectiveness" approach may be the development of the notion of

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[6] Ibid., sec. II, pp. 20-22.

[7] N. L. Gage, An Analytical Approach to Research on Instructional Methods, U.S. Office of Education Report Number BR-5-0252-2 (1966), p. 1.

[8] Helen M. Walker, Preface, in W. H. Lancelot et al., The Measurement of Teaching Efficiency (New York: Macmillan, 1935), pp. ix-xiv.

> "micro-effectiveness." Rather than seek criteria for the over-all effectiveness of teachers in the many varied facets of their roles, we may have better success with criteria of effectiveness in small, specifically defined aspects of the role. Many scientific problems have eventually been solved by being analyzed into small problems, whose variables were less complex.[9]

He then suggested that the complex act of teaching be divided into less complex skills and, following the lead of scientists, criteria of effectiveness for each of the skills be developed.

It was at about this same time that the Stanford Center for Research and Development in Teaching adopted what is now known as the technical skills approach. The micro-teaching clinics were the result of this new approach.

Although micro-teaching at Stanford University has been used primarily for pre-service preparation, Allen and Clark list the following applications:

1. Improving the skills of experienced teachers
2. Refining the skills of supervisors
3. Evaluating teaching performances
4. Piloting and assessing new materials and techniques
5. Research in teaching.[10]

Micro-Teaching at Brigham Young University

The Teacher Education Department of Brigham Young University has to locate enough student teaching stations for 500 student teachers each semester. In an attempt to find a solution to this problem Brigham Young adopted a modified form of micro-teaching in 1966. Because of the large number of trainees, the one supervisor to one trainee technique used at Stanford University could not be used at Brigham Young University. Therefore micro-teaching was expanded to include the trainee's classmates. Advantages in having the class observe and critique fellow trainees include:

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[9] N. L. Gage (ed.), Handbook of Research on Teaching (Chicago: Rand McNally and Co., 1963), p. 120.

[10] Dwight W. Allen and Richard J. Clark, Jr., "Micro-teaching: Its Rationale," The High School Journal, LI (November, 1967), p. 78.

1. Observing others teach and discussing their performance broadens the experience of the observer and therefore lessens the number of actual presentations required by each trainee to alter his own teaching behavior.
2. Use of the trainees as observers expands the evaluation process and sensitizes each trainee to assess his own teaching behavior more critically.
3. Having a group observe the lesson presentation usually results in a variety of creative approaches for presenting similar lessons or concepts.[11]

The procedure used at Brigham Young University was to have a trainee present a four to eight minute lesson to a micro-class of three to five students from the local public schools. When these students were not available peers from the college class were substituted. The presentation was evaluated by the class instructor, the micro-class, and the college class. The presentation was video-taped and replayed immediately so the trainee could see his lesson. The video recording was critiqued by the instructor, the college class, and occasionally by the micro-class. Specific suggestions for improvement were made to help the trainee prepare for a reteach of the same lesson. At Brigham

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[11] W. Dwayne Belt, "Micro Teaching: Observed and Critiqued by a Group of Trainees" (paper presented at the American Educational Research Association Annual Meeting, February 16-18, 1967, New York), p. 2.

Young University the length of time between the teach and reteach lessons varied from one day to a week. The procedure for the reteach session was the same as for the first presentation, with the exception that the evaluation and critique of the reteach was usually briefer.

The aim of each presentation was to teach a specific technique. Some examples of the techniques stressed at Brigham Young University are:

1. Teaching a concept
2. Reinforcing student behavior
3. Asking appropriate questions
4. Interesting and involving students
5. Giving assignments
6. Using inquiry training
7. Teaching a concept non-orally.[12]

After approximately 500 students had participated in micro-teaching sessions at Brigham Young University, several tentative conclusions were drawn:

1. Micro-teaching, with its provisions for immediate feedback and for self-observation by students, offers a unique opportunity for individualized instruction of teacher trainees.

2. Micro-teaching is valuable in introducing the trainee to different types of classroom situations or problems.

3. The use of video tapes in micro-teaching enables the trainee to see himself as he interacts with a group of students and to arrive at some conclusions in regard to his effectiveness in the teaching situation.

4. Performance of students, as judged by supervisors, classmates, and the pupils they teach, is usually

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[12] Dwayne Belt and Hugh Baird, "Micro-teaching in the Training of Teachers: Progress and Problems," Television and Related Media in Teacher Education (Baltimore, Md.: Multi-State Teacher Education Project, August, 1967), p. 20.

> improved--sometimes to a great extent--following the evaluation session and video tape playback.[13]

Student response to the micro-teaching experience was very favorable. Ninety-six per cent of the trainees indicated that they had benefited from the micro-teaching experience. The trainees also agreed that the verbal critiques made by their fellow trainees had been very helpful.

Micro-teaching has also been used in inservice training by Brigham Young University. Although the projects were not described, several tentative conclusions were reported. Most experienced teachers found the micro-teaching sessions more threatening an experience than did the teacher trainees. They usually overcame whatever fears they had after the first or second session, however, and were quite successful in improving specific skills and competencies.

Micro-Teaching at the University of Illinois

A Teaching Techniques Laboratory was organized at the University of Illinois to function as a service unit for instructors in the teacher education program. The laboratory provided different combinations of pupils, rooms, materials, and hardward for each course in the teacher preparation sequence.

One example of the work done in the laboratory has been described by Johnson. Three methods instructors decided their students should have practice in three specific skills: lecture, giving instructinns, and discussion. After instruction in each of the three techniques the forty-eight students were referred to the Teaching Techniques Laboratory.

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[13] Belt, "Micro Teaching: Observed and Critiqued . . ." pp. 4-5.

Each student taught six lessons which were video-taped. The students were supervised by advanced graduate students with no particular training in supervision. All lessons were evaluated using seven-interval observation scales based on a general model of teaching. Pre- and post-treatment lessons were rated by a panel of trained observers from video-tapes. Statistical analysis showed an overall improvement significant at the 0.2 level but not at the 0.1 level. More specifically, in only one of the three skills was there an improvement significant at the 0.1 level.

Johnson did not regard the absence of significant improvement as final, but suggested that the results of the early studies be used as guidelines for making the technique more effective. Problems to be solved include the training of supervisors, the development of a more effective criteria for evaluation of teaching, and further delineation of the specific techniques used in micro-teaching.[14]

Summary of Micro-Teaching

Although micro-teaching has been used extensively at Stanford University and, to a lesser degree, at other institutions, many college and secondary school personnel have not been familiar with the technique. As a result micro-teaching has not been utilized or evaluated as fully as it might have been. Now, as additional research studies are reported and a larger number of educators learn of the technique, there is a good possibility that the quantity of research will increase. The teachers who have had experience with micro-teaching in their preservice education should have some effect on the attitudes of inservice teachers. Since a majority of trainees have developed favorable attitudes toward micro-teaching, it seems reasonable to assume that the applications of micro-teaching to inservice education will also increase.

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[14] William D. Johnson, "Microteaching: A Medium in Which to Study Teaching," The High School Journal, LI (November, 1967), p. 91.

Science Demonstrations

The quantity of literature devoted to science demonstrations is, to say the least, extensive. Therefore, only a brief survey of different types will be presented, and this will be restricted to secondary school science teaching.

The prospective science teacher may see many demonstrations presented in his academic science courses. However, his first contact with learning how to prepare and present demonstrations usually does not come until he takes his first science methods teaching course. In this course the teacher or students may prepare and present demonstrations to the class. The presentations may be evaluated and critiqued by the class to make the class aware of the criteria for effective demonstrations. The class may also discuss the advantages and disadvantages of demonstrations and compare these with the advantages and disadvantages of individual student experiments.

Three texts were chosen for review because they are representative of the general texts used for introductory science methods courses and because they contain specific information about science demonstrations.

In a text by Thurber and Collette five special functions of demonstrations are listed. They are:

1. To set a problem.
2. To illustrate a point.
3. To help solve a problem.
4. As a review.
5. To serve as a climax.[15]

One example of setting a problem is to have a demonstration set up and operating when the students enter the classroom. Observations can be made and hypotheses can be suggested, followed by a laboratory session to solve the problem. Or, once the problem has been defined, additional demonstrations may be presented to solve it. Illustrating points during a lecture or discussion is a common use of demonstrations. Oral reviews can be very boring. Short, simple demonstrations can be very useful in bringing out important points during reviews and, at the same time, keep the attention of the class. Finally, a demonstration can be a very effective way to end a unit, especially when a demonstration can be prepared which shows the relationship between several concepts or principles.

In order to show that demonstrations are valuable teaching techniques but, at the same time, have serious limitations, Thurber and Collette list the advantages and disadvantages of demonstrations. The advantages are:

1. A demonstration guides the thinking of all the pupils into approximately the same channels.

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[15] Walter A. Thurber and Alfred T. Collette, Teaching Science in Today's Secondary Schools (Boston: Allyn and Bacon, Inc., 1959) pp. 128-129.

2. A demonstration is economical of materials.

3. Demonstrations enable a teacher to utilize activities that would be too dangerous for pupils to carry out for themselves.

4. A demonstration may be economical of class time.[16]

In this list of advantages there are some statements very similar to those found in the Thirty-first Yearbook and the Forty-sixth Yearbook of the National Society for the Study of Education. This does seem to indicate that the yearbooks had influenced the writings of these science educators some twenty-five years later.

Listed in the same text by Thurber and Collette are several serious limitations of demonstrations that make them useful only for certain types of learning situations. They are:

1. Visibility is always a problem.

2. Pupils have little opportunity to become familiar with the materials.

3. Much scientific information cannot be grasped adequately by sight and sound alone.

4. A demonstration may go at such a rapid pace that pupils do not grasp each step.

5. During any discussion which results from a demonstration, there may be instances when certain pupils tend to carry the class along, to the detriment of the others.

6. There are few opportunities for active pupil participation during a demonstration.

7. Elaborate demonstrations tend to be too convincing.[17]

Although these limitations are serious ones, they should not be considered as justification for not doing demonstrations. However, teachers should take them into careful consideration when planning demonstrations.

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[16] Ibid., p. 129.

[17] Ibid., pp. 130-131.

While visibility can be a major problem when working with small pieces of apparatus, techniques using overhead projectors have been developed which make it possible to enlarge biological functions or chemical processes to many times their original size.

There is no good reason why students have to become familiar with every piece of equipment in the laboratory. A program which includes both demonstrations and student experiments can provide many opportunities for students to manipulate apparatus and learn laboratory techniques.

Demonstrations do not have to rely on sight and sound alone. Many materials which have to be touched or smelled can be passed from student to student. If this is not possible, students can be brought to the demonstration area.

If a demonstration goes at such a rapid pace that pupils cannot grasp each step it is because the teacher's presentation was too rapid or because the demonstration involved a process which happened too quickly to be seen. If it is the fault of the teacher it can be corrected by paying closer attention to student reactions during the demonstration. If it is the fault of the demonstation, the demonstration should be modified or not used.

In any teaching situation there will be students who tend to carry the class along to the detriment of the others; therefore, this should not be considered a limitation peculiar to demonstrations. It is the responsibility of the teacher to involve the whole class in any learning situation requiring verbal participation by students.

If active student participation is felt to be an absolute necessity, students can be involved in many demonstrations as helpers. Students can assist the teacher by making measurements, reading instruments, recording data on the chalkboard, etc. There are also many demonstrations which can be presented by a student or groups of students.

Finally, the limitations listed here are detrimental only if the teacher allows them to be. A conscientious teacher who is aware of the limitations can plan and present demonstrations in which the limitations are reduced to a minimum.

The following functions of demonstrations are listed in a text by Brandwein, Watson, and Blackwood:

1. To begin a lesson and demonstrate a phenomenon at variance with ordinary experience.
2. To end a lesson leading to an extension of work at home.
3. To develop a point during the lesson.
4. To highlight safety procedures in the laboratory.
5. To demonstrate processes generally too dangerous or too complex for students to handle.
6. To demonstrate additional aspects of laboratory work.[18]

Richardson lists eight clearly defined functions of demonstrations. They are:

1. To solve a problem

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[18] Paul F. Brandwein, Fletcher G. Watson, and Paul E. Blackwood, Teaching High School Science: A Book of Methods (New York: Harcourt, Brace and World, Inc., 1958), p. 476.

2. To explain, to make clear by analysis
3. To verify, substantiate, and review
4. To supply an application
5. To evaluate student achievement
6. To create a problem
7. To show methods and techniques
8. To display objects and specimens.[19]

In these last two texts are listed basically the same functions of demonstrations as were listed in the first text reviewed. Although the functions are worded slightly differently in each text, there does appear to be a general agreement among the authors as to the most effective utilization of demonstrations.

Richardson also lists the criteria of good demonstrations. They are:

1. The demonstration should be tried out in advance.
2. The purpose of the demonstration should be clear. The purpose may not be revealed in advance of the actual demonstration, but if not, it should be revealed as the demonstration proceeds.
3. The demonstration should be visible to everyone in the room.
4. The apparatus used should be as simple as possible. The complexity of the apparatus should not obscure the purpose of the demonstration.
5. The demonstration should be utilized as fully as possible in the light of its purposes.[20]

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[19] John S. Richardson, Science Teaching in Secondary Schools (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1957), pp. 78-79.

[20] *Ibid.*, pp. 81-82.

This list of criteria was the basis for the development of the demonstration evaluation form used in this study. A description of the development of the form will be discussed in Chapter III.

In addition to advantages, disadvantages, limitations, etc., each of these texts also contains many examples of the different types of demonstrations.

General texts such as these are valuable sources of information for both the preservice and inservice science teacher. The preservice science teacher should know when and how demonstrations can be effectively presented. The inservice teacher needs to review his teaching techniques periodically.

Additional general methods texts for science teachers have been written by Burnett;[21] Woodburn and Obourn;[22] Massey;[23] Lacy;[24] and Heiss, Obourn and Hoffman.[25] Although not written for American science teachers, the UNESCO Sourcebook for Science Teaching[26] is an excellent resource for all science teachers.

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[21] R. Will Burnett, Teaching Science in the Secondary School (New York: Holt, Rinehart, and Winston, 1957).

[22] John H. Woodburn and Ellsworth S. Obourn, Teaching the Pursuit of Science (New York: The MacMillan Company, 1965).

[23] Norman Bland Massey, Patterns for the Teaching of Science (Toronto: The MacMillan Co. of Canada Limited, 1965).

[24] Archie L. Lacey, Guide to Science Teaching in Secondary Schools (Belmont, Calif.: Wadsworth Publishing Company, Inc., 1966).

[25] Elwood D. Heiss, Ellsworth S. Obourn, and C. Wesley Hoffman, Modern Science Teaching (New York: The Macmillan Co., 1950).

[26] United Nations Educational, Scientific, and Cultural Organization, Sourcebook for Science Teaching (Paris, 1962).

The biological science teacher or physical science teacher can find more specific information in books by Morholt, Brandwein, and Joseph; Joseph et al.: or Richardson and Cahoon. Teaching High School Science: A Sourcebook for the Biological Sciences[27] includes demonstrations, projects, laboratory procedures, etc., selected after a study of fifty-eight courses in general science, biological science, and health. The demonstrations, projects, laboratory procedures, etc. in Teaching High School Science: A Sourcebook for the Physical Sciences[28] were selected after a study of over forty courses in general science, chemistry, physics, and earth science. The Physical Science Study Committee physics course is included. Many challenging demonstrations appear in Methods and Materials for Teaching General and Physical Science.[29]

Even more specialized books for secondary school biology, chemistry, and physics teachers include those written by Schwab,[30] Alyea,[31] and Sutton.[32]

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[27] Evelyn Morholt, Paul E. Brandwein, and Alexander Joseph, Teaching High School Science: A Sourcebook for the Biological Sciences (New York: Harcourt, Brace, and Co., 1958).

[28] Alexander Joseph et al., Teaching High School Science: A Sourcebook for the Physical Sciences (New York: Harcourt, Brace and World, Inc., 1961).

[29] John S. Richardson and G. P. Cahoon, Methods and Materials for Teaching General and Physical Science (New York: McGraw-Hill Book Co., Inc., 1951).

[30] Joseph J. Schwab, Biology Teachers' Handbook (New York: John Wiley and Sons, Inc., 1963).

Journals related to science teaching have always been a valuable source of ideas for demonstrations as have been state and local curriculum guides and teachers guides to science course improvement projects such as BSCS, PSSC, CBA, etc. The Science Education Information Analysis Center has published two general bibliographies which include much of this literature. General Bibliography 3 is titled Equipment and Materials[33] and includes documents describing science apparatus, science textbooks, models, and other supplies used in science teaching. General Bibliography 1 is titled Instructional Procedures[34] and includes documents describing or evaluating methods, procedures, and techniques for teaching, among which are demonstration techniques.

There is no scarcity of resource materials for biology, chemistry, general science, or physics teachers who want to use demonstrations in their teaching. The basic problem, the subject of this research, was to determine if experience in micro-teaching would improve the effectiveness of science demonstrations presented by student teachers.

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[31] Hubert N. Alyea, TOPS in General Chemistry: Tested Overhead Projection Series (Easton, Pa.: Journal of Chemical Education, 1967).

[32] Richard M. Sutton, Demonstration Experiments in Physics (New York: McGraw-Hill Book Company, Inc., 1938).

[33] Science Education Information Analysis Center, General Bibliography Series: Bibliography 3--Equipment and Materials (Columbus, Ohio: December, 1967).

[34] Science Education Information Analysis Center, General Bibliography Series: Bibliography 1--Instructional Procedures (Columbus, Ohio: December, 1967).

Literature Related to the Dogmatism Scale

The Open and Closed Mind was written by Milton Rokeach after nearly nine years of research on the nature of belief systems. Using the term belief-disbelief system to include the total system of beliefs and disbeliefs, Rokeach wrote:

> The belief system is conceived to represent all the beliefs, set, expectancies, or hypotheses, conscious and unconscious, that a person at a given time accepts as true of the world he lives in. The disbelief system is composed of a series of sub-systems rather than merely a single one, and contains all the disbeliefs, sets, expectancies, conscious and unconscious, that, to one degree or another, a person at a given time rejects as false.[35]

The author assumed that open and closed belief-disbelief systems are at opposite ends of a continuum. The term high dogmatic is used for a closed system and low dogmatic for an open system.

To develop a definition of an open or closed belief-disbelief system it is necessary to examine the way a person acts in different situations. Information which can influence this action may be relevant or irrelevant and may come from within the person or from external sources. The degree to which a person's system is open depends on how well he can receive information and evaluate it on its own merit and, at the same time, reject irrelevant pressures.

Rokeach described these irrelevant pressures as follows:

> Examples of irrelevant internal pressures that interfere with the realistic reception of information are unrelated habits, beliefs, and perceptual cues, irrational ego motives, power needs, the need for self-aggrandizement, the need to allay anxiety, and so forth. By irrelevant

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[35] Milton Rokeach, The Open and Closed Mind (New York: Basic Books, Inc., 1960), p. 33.

> external pressures we have in mind most particularly the pressures of reward and punishment arising from external authority; for example, as exerted by parents, peers, other authority figures, reference groups, social and institutional norms, and cultural norms.[36]

Rokeach also stated that information a person receives from a source also contains information about the source. A person with open system should be able to distinguish between the two types of information and evaluate each on its own merits.

The Dogmatism Scale was developed deductively. Rokeach examined varied definitions of open and closed systems, then constructed statements to measure the characteristics found in the definitions. Five editions of the scale were tried using a total of eighty-nine items. The last edition, Form E, contains the best forty items.

The items on the Rokeach Dogmatism Scale, Form E, are divided into three general groups, then subdivided as follows:

I. Items involving the belief-disbelief dimension.
    A. Isolation within and between belief and disbelief systems.
        1. Accentuation of differences between the belief and the disbelief systems.
        2. The perception of irrelevance.
        3. The co-existence of contradictions within the belief system.
    B. Relative degrees of differentiation of the belief and the disbelief systems.
        1. Relative amount of knowledge possessed.
        2. Dedifferentiation within the disbelief system.

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[36] *Ibid.*, p. 57.

II. Items involving the central-peripheral dimension.

  A. Specific content of primitive beliefs.

    1. Beliefs regarding the aloneness, isolation, and helplessness of man.

    2. Beliefs regarding the uncertainty of the future.

    3. Beliefs about self-adequacy and inadequacy.

    4. Self-aggrandizement as a defense against self-inadequacy.

    5. Paranoid outlook on life.

  B. Formal content of the intermediate belief region.

    1. Authoritarianism.

    2. Intolerance.

  C. Interrelations among primitive, intermediate, and peripheral beliefs.

    1. Tendency to make a party-line change.

    2. Narrowing (referring to the selective avoidance of contact with facts, events, etc., incongruent with one's belief-disbelief system).

III. Items involving the time-perspective dimension.

  A. Attitude toward the past, present, and future.

  B. Knowing the future.

  C. Belief in force as a way to revise the present.[37]

Although Rokeach used the Dogmatism Scale in many studies, the objective of the majority of the studies was to determine the reliability and validity of the scale. The studies reviewed in the next section are more closely related to teacher education.

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[37] *Ibid.*, pp. 73-80.

Applications of Rokeach Dogmatism Scale

In 1960 Kemp published the results of a study whose purpose was to compare the critical thinking ability of people who were high and low in dogmatism. A total of 500 male and female freshmen students from Olivet College, Alma College, Michigan State University, and Salem College participated. The Rokeach Dogmatism Scale Form E was administered to these 500 students. The 150 students with the lowest dogmatism scores and the 150 students with the highest dogmatism scores were each asked to solve fifty problems involving critical thinking.

The conclusions reached in this study were that low dogmatics are more successful solving problems involving critical thinking. Where decisions can be made only after careful deliberation the low dogmatics make fewer mistakes.

Two implications of this study are important in the preservice education of science teachers. Prospective teachers should be given as many opportunities as possible to be involved in critical thinking activities. The second is that able students may not perform up to their ability due to a high dogmatism rating.[38]

In 1963, Kemp conducted a study with 80 freshmen students, divided evenly between experimental and control groups, to compare improvement in critical thinking between high dogmatics and low dogmatics.

The experimental group was divided into five subgroups of four low dogmatics and four high dogmatics each. Each subgroup spent ten one-hour sessions solving and analyzing critical thinking problems. All groups were given the Watson-Glaser Critical Thinking Appraisal.

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[38] C. Gratton Kemp, "Effect of Dogmatism on Critical Thinking," Journal of School Science and Mathematics (April, 1960), pp. 314-319.

Kemp concluded that although there is not likely to be any improvement in critical thinking abilities in a regular classroom situation, the small group atmosphere of the study resulted in greater improvement among the low dogmatics.[39]

In 1964 Kemp conducted a study in which he administered the Rokeach Dogmatism Scale Form E and the Edwards Personal Preference Scale to 120 university students. The results of the study indicated that: "the open-minded have a greater need for autonomy, dominance, intraception, and heterosexuality; the closed-minded a greater need for abasement, succorance, nurturance, and endurance."[40]

An implication of the study was that persons with open and closed minds require different psychological climates to achieve optimum satisfaction. Closely associated with this was the implied need for different types of learning situations if students with open and closed minds are to attain their maximum level of achievement.

Kingsley conducted a study to investigate the open-mindedness and commitment to teaching of a group of 255 students entering a college of education and a group of 422 students completing a course in Human Growth and Learning. The group entering the college of education was enrolled in the Human Growth and Learning course during the study.

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[39] C. Gratton Kemp, "The Improvement of Critical Thinking in Relation to Open and Closed Belief Systems," Journal of Experimental Education (April, 1963), pp. 321-323.

[40] C. Gratton Kemp, "Comparison of Manifest Needs of Open and Closed Minds," Journal of Research in Science Teaching, Vol. 2, No. 2 (1964), pp. 107-108.

This group completed a questionnaire on commitment and the Rokeach Dogmatism Scale at the beginning and the completion of the course. The other group completed the two instruments only once.

The results of the study indicated very little change in dogmatism during one semester in the college of education. However, there was a tendency for the students who were committed to teaching to become less dogmatic. There was also a tendency for dogmatic students to become more dogmatic.[41]

Johnson investigated the relationship between student teachers' dogmatism and their success in student teaching. A twenty-three item rating scale was used by college supervisors and cooperating teachers to determine the student teachers' success. Each student teacher was given the Rokeach Dogmatism Scale Form E before and after the student teaching experience.

The major conclusion of the study was that the dogmatism rating could not be used as a prediction of success in student teaching when the degree of success is determined by the college supervisor or cooperating teacher. One other very significant result of the study was that student teachers became more open-minded if their cooperating teachers were open-minded and vice versa.[42]

In the study in which Sorenson compared laboratory-centered and lecture-demonstration-centered patterns of instruction, the Rokeach

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[41] Ruth Wattie Kingsley, "Commitment to Teaching and Open-Mindedness of Teachers in Training," Ph.D. dissertation, University of Arizona, 1966, Abstract: Dissertation Abstracts 26:66-3142, pp. 6531-6532.

[42] James Sydney Johnson, "The Relationship of Open- and Closed-Mindedness to Success in Student Teaching," Ed.D. dissertation, George Peabody College for Teachers, 1966, Abstract: Dissertation Abstracts 27: 66-11,230, p. 1282-A.

Dogmatism Scale Form E was used for pre- and post-testing. The results of this testing indicated no significant change in dogmatism for the lecture-demonstration-centered group at any level of I.Q. However, when the laboratory-centered group was divided into sub-groups according to their I.Q. with ranges of 80-109, 110-119, 120-129, and 130-139, all but the highest group showed a decrease in the mean dogmatism score significant at the one percent level.[43]

Summary of Dogmatism Research

Although the Dogmatism Scale has been available to researchers for less than ten years, the research which has been conducted has resulted in some very important implications for teacher education. The relationships between dogmatism and critical thinking skills, the necessary conditions for changing a person's level of dogmatism, and the need for different types of learning situations for students with different levels of dogmatism are factors which should seriously be considered when designing a teacher education program. Additional research should be conducted at the college and secondary school levels to substantiate the results of the studies reviewed in this section and to correlate dogmatism with teaching skills such as leading discussions, presenting demonstrations, and planning student experiments.

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[43] LaVar Leonard Sorensen, "Change in Critical Thinking Between Laboratory Centered and Lecture Demonstration-Centered Patterns of Instruction in High School Biology" (unpublished Ed.D. dissertation, Oregon State University, 1966), pp. 94-95.

CHAPTER III

DESIGN OF THE STUDY

Introduction

This study was conducted in two parts. In part one, conducted during Autumn Quarter, 1967 and Winter Quarter, 1968, selected groups of students participated in the micro-teaching experience. Part two overlapped part one during Winter Quarter, 1968 and continued through Spring Quarter, 1968. During part two student teachers presented demonstrations to their secondary school science classes. Those in Groups A and B had participated in the micro-teaching experience; those in Group C had not. The objective of part two was to evaluate these demonstrations to determine if the micro-teaching experience was worthwhile. The procedure for the study will be developed in two parts, in the same order as the study was conducted.

Part One

A general description of the criteria used to define the populations for the study will be discussed first, followed by a detailed description of methods used to select the students in each group.

The population for part one of the study included all students, undergraduate and graduate, who were enrolled in Education 625 or Education 627 either Autumn Quarter, 1967 or Winter Quarter, 1968.

Table number one shows the enrollment for the two courses for Autumn Quarter, 1967 and Winter Quarter, 1968.

TABLE 1

LABORATORY PRACTICUM ENROLLMENTS FOR AUTUMN QUARTER, 1967 AND WINTER QUARTER, 1968

	Autumn, 1967		Winter, 1968	
	Undergraduate	Graduate	Undergraduate	Graduate
Education 625	21	6	15	0
Education 627	6	6	17	5

Selection of Group A

The sub-population from which the students in Group A were selected was limited to the undergraduate students in the population who would be student teaching the quarter immediately after the one in which they participated in the micro-teaching. In order to determine which students would be included in the sub-population, the investigator attended the first meeting of Education 625 and Education 627 Autumn Quarter, 1967 and Winter Quarter, 1968. At that time each member of the class completed a Research Registration Form which included his name, college address, college phone number, major, minor, when he expected to be student teaching, and his first and second choice of subjects for student teaching.

At the second meeting of each class, the investigator discussed the general procedure of the study with the entire class. He then discussed with prospective Group A students what they would be expected to do during the quarter. After this discussion students who did not wish to participate were removed from the sub-population. Two students chose not to participate during Winter Quarter, 1968.

Between the second and third meeting of each class Autumn and Winter Quarters, the students in Group A were randomly selected. One student in Education 627 and three students in Education 625 were selected Autumn Quarter, 1967. During Winter Quarter, 1968 Group A was composed of four students from Education 627 and two students from Education 625. At the third meeting of each class the investigator announced which students had been selected for Group A. He also gave each member of the class a copy of the Demonstration Evaluation Form and explained its intended use. The students were asked to examine the form before the next class period when they would have an opportunity to ask questions about it.

During the fourth meeting of each class Autumn and Winter Quarters the investigator video-recorded a short interview with each student in Group A. The objectives of the interview were to allow the students to become familiar with portable video-recording equipment and to give the investigator an opportunity to see if there were any adverse reactions to the camera and microphone. Each recording was immediately replayed to give the student an opportunity to see and hear himself. For a majority of the group it was the first time. Happily there were no complications and all students agreed to stay in the study.

Table number two shows the number of students in Group A in Education 625 and Education 627 Autumn Quarter, 1967 and Winter Quarter, 1968.

TABLE 2

DISTRIBUTION OF GROUP A STUDENTS AUTUMN QUARTER, 1967 AND WINTER QUARTER, 1968

	Autumn, 1967	Winter, 1968
Education 625	3	2
Education 627	1	4

Selection of Group B

After the students for Group A had been selected, the remaining students in each class were invited to participate as members of Group B. At this time they were told specifically what they would be expected to do and approximately how much time they would be absent from class. All students agreed to participate if selected. The actual selection of students for each micro-class was made only a few minutes before each micro-teaching session. This procedure will be described later in this chapter.

Selection of Group C

Although some provisions were made during part one of the study for selecting students for Group C, the final decision was not made until after student teachers had met for their first seminar of each quarter. The procedure for selecting the students for Group C will be described in Part Two of this chapter.

Instructions to Group A

Immediately after the final selection of students for Group A, those selected were given specific instructions in writing for preparing demonstrations for the micro-classes. The instructions were:

1. Each teacher in Group A will prepare and present two ten to twenty-five minute demonstrations during the quarter.

2. Although the function of each demonstration can be chosen by the teacher, the demonstrations will be presented to peer groups. The students in the micro-classes will not be play acting as secondary students. Therefore the demonstrations should be prepared at a level which will provide a meaningful learning experience for them.

3. Each teacher will prepare two copies of a lesson plan using the form provided by the investigator. This form includes: the topic of the demonstration, the objectives of the demonstration, the science content included, the materials to be used, and the procedure to be followed.

4. The teacher will be responsible for the apparatus used in the demonstration. The teacher may use any equipment and supplies in the Science Teaching Center, build his own apparatus in the shop, or borrow the apparatus from some other department.

5. The instructors of the methods courses will provide any advice and assistance they can during the quarter.

Development of the Demonstration Evaluation Form

Using the criteria for effective demonstrations presented in Richardson[1] as a basis, a preliminary form of the demonstration evaluation form was developed during Spring Quarter, 1967. The preliminary form was used to evaluate demonstrations presented to the students in Education 625 and Education 627 Spring Quarter, 1967. The demonstrations were presented by students and evaluated by other students in the classes. The students who used the form were asked to make any constructive criticism they could with respect to the form. None was received.

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[1] Richardson, Science Teaching in Secondary Schools.

During Summer Quarter, 1967 the investigator submitted a slightly modified form to his reading committee, Professors Schlessinger, Andrews, and Duncan. Their recommendations were incorporated into the final form which was used during part one of the study.

Scheduling of Micro-Teaching Sessions

Final arrangements for each micro-teaching session were made at least a week in advance. The instructors of the two laboratory practicums were consulted so that the sessions could be scheduled on days when individual work was planned. The instructors of the laboratory practicums also cooperated with the investigator by releasing the students in Groups A and B from regularly scheduled class time.

In order to interrupt the laboratory practicums as little as possible all micro-teaching sessions were conducted in a small seminar room located in close proximity to the Science Teaching Center. Facilities available in this room were hot and cold water, electrical outlets, a chalk board, and tables and chairs. Apparatus used in demonstrations was usually transported to the seminar room on a small laboratory cart.

The investigator arranged the tables and chairs in the seminar room approximately one hour before each micro-teaching session.[2] The portable video recording equipment was also tested before each session.

Procedure for Each Micro-Class

A total of twenty micro-teaching sessions were held during Autumn Quarter, 1967 and Winter Quarter, 1968. The procedure described here was followed as closely as possible for all sessions.

The student who would be presenting the demonstration usually arrived in time to set up the demonstration before regular class time. As soon as the class period started the final selection of students for the micro-classes was made. The information which had been gathered early in the quarter had been transferred to five by eight inch cards. For each course there were two groups of cards--one for the graduate students and one for the undergraduate students. Each group of cards was shuffled before each class to place them in random order. The first graduate student and the first three undergraduate students made up the micro-class for the first trial of the day. If a student was absent his card was placed on the bottom of the pile and an additional student was selected.

The micro-class chosen for the first trial then assembled in the seminar room. The first time each member of Groups A or B participated in a micro-teaching session, he signed a Video Tape Recording Release and Waiver.[3] Although all students had been told that all recordings would be erased when the study was completed, they were reminded of this the day they signed the waiver.

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[2] See Appendix D for room arrangement.

[3] See Appendix E.

Just before each micro-teaching session the investigator reminded the students in the micro-class to be as honest as possible when marking the evaluation forms. They were also reminded that a few of the items on the evaluation form could be checked during the presentation, while others could not be checked before the demonstration was completed.

The teacher then presented the demonstration. The presentation was recorded by the investigator who was also the cameraman for the study.

Immediately after the presentation was finished the micro-class completed the evaluation forms, and the investigator collected them. The micro-class was then encouraged to verbally critique the presentation. Usually during this period of time the strong and weak points of the presentation were stressed and suggestions for improvement were made. Often, however, the micro-class would be so interested in the demonstration topic that they would want to continue discussing it after the presentation was officially completed. In general the criticisms were made in a very professional manner and accepted very gracefully by the teacher.

During the critique session the investigator totaled the scores on each of the four evaluation forms and calculated a mean score for that trial. In order to give the teacher an additional indication of the strong and weak points of the presentation, the investigator also summed the responses for each of the ten items on the four forms.

The high and low sums here usually agreed with the strong and weak points brought out during the verbal critique session.

After the micro-class had completed the verbal critique and had gone back to class, the investigator replayed the video recording for the teacher. Although self-evaluation was stressed, the teacher had the verbal critique and the evaluation sheets as guidelines when viewing the play-back. The investigator also viewed the recording with the teacher. The role of the investigator at this time was to help the teacher see the strong and weak points of the presentation. The recorder could be stopped at any time during the replay and reversed if necessary so that the teacher could see parts of the recording a second time.

After the replay of the recording was completed, the teacher was given ten to fifteen minutes to prepare for the second trial. During this time the investigator selected the micro-class for the second trial, using the same procedure as with the first.

The procedure used for the second trial was identical to that used for the first trial with one exception. There was not time for the teacher to view the second video recording immediately after the presentation and verbal critique. Therefore, arrangements were made with each teacher to meet with the investigator, usually within two or three days. Each teacher viewed the recording of the first trial for the second time, and then the recording of the second trial. Viewing both recordings gave the teacher the opportunity to see what changes in procedure he had made between the first and second trials. The teacher was also able to examine both sets of demonstration evaluation forms while he was viewing the recordings.

Each teacher presented a second demonstration approximately three weeks after the first. The procedure for the second demonstration was identical to that of the first with one exception. Not all of the teachers could find time to view the video recording of the second trial. However, all teachers were given copies of the summary sheets for both demonstrations.

During the last week of classes Autumn Quarter, 1967 and Winter Quarter, 1968 all students in Group A and all students in the micro-classes were asked to respond to a questionnaire.[4] The objective of the questionnaire was to determine the students' reactions to the micro-teaching experience, either as a teacher or member of a micro-class.

Part Two

In part two of the study each of the teachers in Groups A, B, and C presented demonstrations to his secondary school science classes.

The ten students in Group A had presented demonstrations in part one of the study and the procedure for selecting them has already been described.

During part one of the study each two trials of a demonstration had required the participation of eight students from Group B. With the exception of the Education 635 class Winter Quarter, 1968, in which no graduate students were enrolled, each micro-class was composed of one graduate student and three undergraduate students. In all, thirteen graduate students and thirty-two undergraduate students participated as members of micro-classes. From the group of twenty-one who were student teaching Winter or Spring Quarters, ten were selected for evaluation in part two of the study.

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[4] See Appendix F.

During Winter Quarter, 1968 and Spring Quarter, 1968, twenty-nine student teachers met the criteria for Group C. Five biological science majors and five physical science majors were randomly selected for Group C.

The student teachers in Groups A, B, and C were assigned to schools in the Columbus Public School System and surrounding school districts. Arrangements were made through Mr. Horace C. Hawn, Acting Coordinator of Student Field Experience, for the investigator to evaluate a demonstration presented by each of the student teachers in the study.

Two additional evaluations were made of each demonstration. The people making these evaluations included: Mr. Robert E. McNemar, Science Coordinator of the Columbus Public Schools; Professor Fred R. Schlessinger, Professor of Science Education at The Ohio State University; the University Supervisors of Student Teachers, in the area of Science, from The Ohio State University; and the Cooperating Teachers working with the student teachers in the study.

The Demonstration Evaluation Form[5] used to evaluate demonstrations presented in the secondary schools was a slightly modified form of the one used for the micro-teaching sessions. The modification consisted of a slight change in the wording of each question to enable persons not participating in the demonstration to evaluate the demonstration from their point of view.

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[5] See Appendix G.

The Rokeach Dogmatism Scale Form E was administered to all student teachers in the area of secondary school science Winter Quarter, 1968 and Spring Quarter, 1968. The Dogmatism Scale was administered in the regularly scheduled student teaching seminar. The student teachers were told that individual results would not be published. The investigator also agreed to discuss individual results with each student teacher.

Statistical Analysis

After consultation with the chairmen of the Psychology Department and the Statistics Department the investigator chose the following statistical tests to test the hypotheses of the study.

With the cooperation of the Computer Center of The Ohio State University Research Foundation, separate correlation studies were run on the 160 demonstration evaluation forms from part one of the study and the 90 forms from part two of the study. For each of the two groups of forms the following computations were made:

1. The correlations between the responses to each question on the evaluation forms and the responses to each of the other questions on the forms were calculated. The correlations between the responses to each question and the total score on each form was also calculated.

2. The mean score of all the responses to question number one, question number two, etc. for both groups of evaluation forms was

calculated. The mean of the total scores on each form was calculated for each group. Finally the standard deviations of the means were calculated.

The results of these calculations were used to calculate the Kuder-Richardson reliability coefficients for the two groups of forms.

Justified by the results of the preceding computations, a t-test was made to determine if there was any improvement between the first and second trials of each demonstration presented in part one of the study. A t-test was also made to determine if there was any improvement between the second trial of the first demonstration and the second trial of the second demonstration for each student in Group A. The hypothesis was tested at the 0.05 level of significance.

Finally, the investigator summarized each of the demonstrations. Each summary includes the objectives of the demonstration, the apparatus used, and the procedure. Strong and weak points in the presentation are discussed along with any major changes between the first and second trials.

When the evaluations of the demonstrations presented in the secondary schools were completed, an analysis of covariance with multiple covariates was computed. The analysis-of-variance variable was the mean of the three evaluations for each of the student teachers in Groups A, B, and C. The covariates for each student teacher were his point hour ratio in his science major, his point hour ratio in the professional school, and his rating on the Rokeach Dogmatism Scale.

CHAPTER IV

THE RESULTS

The results of the study will be presented in the following order: All data related to the micro-teaching sessions, and the analysis of this data, will be reported first. Included will be the data from the demonstration evaluation forms and the results of the student questionnaires. The results of part two of the study will include the data from the evaluations of student teachers and the scores obtained from the Dogmatism Scale. The data obtained from students' permanent college records will be included.

Part One

Results of Micro-Teaching Sessions

In part one of the study ten students in either Education 625 or Education 627 presented demonstrations to micro-classes composed of four peers. Each student presented two trials each of two different demonstrations. Each trial was recorded on video tape by the investigator. The micro-class verbally critiqued each presentation. Each presentation was also evaluated by the micro-class using the demonstration evaluation form.

The data obtained from the demonstration evaluation forms are presented in Table 3. The teachers who presented the demonstrations

TABLE 3

EVALUATION SCORES OF THE DEMONSTRATIONS PRESENTED BY STUDENTS IN GROUP A IN MICRO-TEACHING SESSIONS

Teacher Number	Dem.	Trial 1 Total Scores				X_1 Mean	Trial 2 Total Scores				X_2 Mean
1	1	37	31	41	35	36.00	27	40	30	23	30.00
1	2	35	39	35	44	38.25	36	34	42	37	37.25
21	1	32	35	37	46	37.50	44	29	34	35	35.50
21	2	28	28	31	26	28.25	32	30	43	47	38.00
22	1	44	28	37	36	36.25	41	38	42	36	39.25
22	2	36	48	40	42	41.50	44	39	41	37	40.25
23	1	39	35	30	31	33.75	42	32	41	32	36.75
23	2	34	40	35	38	36.75	41	40	33	38	38.00
24	1	47	36	32	38	38.25	33	31	43	43	37.50
24	2	31	40	41	38	37.50	48	39	39	49	43.75
51	1	39	33	39	31	35.50	38	27	33	40	34.50
51	2	31	35	31	39	34.00	23	38	35	41	34.25
52	1	33	39	38	39	37.25	30	36	40	39	36.25
52	2	29	40	30	36	33.75	39	44	37	38	39.50
53	1	40	46	46	41	43.25	41	39	39	42	40.25
53	2	32	40	39	47	39.50	47	45	39	41	43.00
81	1	44	42	39	37	40.50	43	46	43	43	43.75
81	2	32	34	36	36	34.50	40	39	49	49	44.25
82	1	42	48	46	39	43.75	39	40	42	36	39.25
82	2	36	36	47	47	41.50	48	43	36	43	42.50

are identified by number only. The total scores assigned to each trial of a demonstration by the four members of the micro-class are listed, followed by the mean score for each trial.

Before the data in Table 3 could be statistically analyzed it was necessary to examine the responses to individual questions on the evaluation forms. On each of the 160 evaluation forms the response to each question was paired with the response to each of the other nine questions and with the total score. A correlation study was conducted utilizing the computer services of The Ohio State University Research Center. The resulting correlation matrix is presented in Table 4.

TABLE 4

CORRELATION COEFFICIENTS OF RESPONSES TO QUESTIONS ON THE DEMONSTRATION EVALUATION FORMS USED IN THE MICRO-TEACHING SESSIONS

Question	1	2	3	4	5	6	7	8	9	10	Σ
1	1.00	0.27	0.26	0.15	0.25	0.34	0.32	0.32	0.24	0.28	0.55
2		1.00	0.51	0.26	0.25	0.28	0.35	0.38	0.42	0.47	0.63
3			1.00	0.36	0.43	0.39	0.38	0.39	0.38	0.53	0.69
4				1.00	0.38	0.28	0.17	0.22	0.36	0.26	0.51
5					1.00	0.41	0.28	0.31	0.35	0.36	0.62
6						1.00	0.42	0.35	0.35	0.43	0.67
7							1.00	0.39	0.39	0.48	0.65
8								1.00	0.48	0.47	0.67
9									1.00	0.65	0.72
10										1.00	0.76
Σ											1.00

The mean and standard deviation were also calculated for the responses to each question and for the total score on each form. These figures are presented in Table 5.

Utilizing the information in Table 5 the following formula was used to calculate the Kuder-Richardson reliability coefficient:

$$r_{KR \#20} = \frac{10\ (\sigma_\Sigma)^2\ \sigma_i^2}{9\ (\sigma_\Sigma)^2}$$

σ_Σ = standard deviation of the total score on the form. σ_i = standard deviation of the responses to each question on the form. The resulting value of r_{KR} was 0.844.

TABLE 5

MEANS AND STANDARD DEVIATIONS OF RESPONSES TO QUESTIONS ON THE DEMONSTRATION EVALUATION FORMS USED IN THE MICRO-TEACHING SESSIONS

Question	Mean	Standard Deviation
1	3.32	0.97
2	3.88	0.79
3	4.20	0.70
4	4.44	0.72
5	4.14	0.86
6	3.46	1.01
7	3.34	0.89
8	3.66	0.84
9	3.87	0.92
10	3.71	0.87
Σ	38.03	5.56

After consultation with the Chairman of the Psychology Department the author decided that this relatively high value of the Kuder-Richardson reliability coefficient and the positive values in the correlation matrix provided justification for statistical analyses of the data in Table 3.

Twenty different demonstrations were presented and evaluated during part one of the study. To determine if there was an overall change in effectiveness between the first and second trials of each demonstration, a t-test of the difference of the means was calculated. The mean of the first trials was compared with the mean of the second trials. The value of t was computed using the following equation:

$$t = \frac{\frac{\Sigma d}{n}}{\frac{n \, \Sigma d^2 - (\Sigma d)^2}{n^2 \, (n - 1)}}$$

d = the algebraic difference between the mean ratings of the first and second trial of each demonstration.

n = the number of demonstrations. For this computation n = 20.

The value computed for t was 1.38. Using n - 1 degrees of freedom, this value of t was not significant at either the 0.05 level or the 0.10 level. Therefore the null hypothesis that there would be no significant overall change in effectiveness between the first and second trials of each demonstration was not rejected.

A comparison of the ratings of the first and second demonstrations led to the following observations. Between the first and second trials of the first demonstrations there were seven instances in which the mean score decreased and three instances in which it increased. Between the first and second trials of the second demonstrations, however, there were eight instances in which the mean score increased and two instances in which it decreased. These observations led to separate tests of the first and second demonstrations.

When the two trials of the first demonstration were tested the value of t was -0.89. With nine degrees of freedom, this was not significant at the 0.05 level. When the two trials of the second demonstration were tested the value of t was 2.68. With nine degrees of freedom, this value was significant at the 0.05 level.

Although only one hypothesis was involved, additional t-tests were made to determine what changes in effectiveness occurred between the first trials of the two demonstrations, between the second trials of the two demonstrations, and between the first trial of the first demonstration and the second trial of the second demonstration.

An examination of Table 3 reveals that seven of the ten students received a lower average rating on the first trial of the second demonstration than on the first trial of the first demonstration. The value of t calculated for this difference was - 1.20 which, with nine degrees of freedom, was not significant either at the 0.05 level or at the 0.10 level.

Nine of the ten students received higher ratings on the second trial of the second demonstration than they did on the second trial of the first demonstration. The value of t calculated for this difference was 3.68 which was significant both at the 0.05 level and at the 0.01 level. Therefore the null hypothesis that no significant change would occur between the second trial of the first demonstration and the second trial of the second demonstration was rejected.

The difference between the mean scores of the first trial of the first demonstration and the second trial of the second demonstration was also tested. The resulting value of t was 2.43 which, with nine degrees of freedom, was significant at the 0.05 level.

Student Questionnaires

At the conclusion of the micro-teaching activities in part one of the study, each student in Group A and each student in the micro-classes was requested to complete a questionnaire about his reactions to the study. Separate questionnaires were developed for the two groups. The questions and responses by students in Group A are presented in Table 6.

Since the micro-classes were composed of both undergraduate and graduate students, their responses to the questionnaire are reported separately in Table 7. The responses to both questionnaires will be discussed in Chapter V.

The summaries of demonstrations presented in the micro-teaching sessions are presented in Appendix H.

Part Two

Each student teacher in Groups A, B, and C presented a demonstration to his secondary school science class. Each presentation was evaluated by three persons from the group described on page 57. The three scores and the mean for each of the thirty student teachers are presented in Table 8.

Before an analysis of covariance was made of this data a correlation study was made of the individual responses to the questions on the evaluation forms. Ninety forms were used during part two of the study. The resulting correlation matrix is presented in Table 9.

The mean rating and standard deviation were calculated for each of the questions. The results of these calculations are presented in Table 10.

The data in Table 10 was used to compute the Kuder-Richardson reliability coefficient. The value of the coefficient computed for this form was 0.879.

TABLE 6

RESPONSES TO THE QUESTIONNAIRE BY STUDENTS IN GROUP A

Question	No	Yes
1. Do you believe that the presence of the video recording equipment affected the presentation of your first demonstration to the micro-class?	9	1
2. Do you believe that the presence of the video recording equipment affected the presentation of your second demonstration?	10	0
3. Did the presence of the experimenter make you feel uncomfortable?	9	1
4. Did you feel uncomfortable because there were experienced teachers in the micro-classes?	4	6
5. Did you feel uncomfortable presenting demonstrations to a peer group?	7	3
6. Do you think that the demonstration evaluation sheets helped you prepare for the second trial of each demonstration?	3	7
7. Do you think that the verbal critiques helped you prepare for the second trial of each demonstration?	1	9
8. Do you feel that you did better on the re-teaches?	6	4
9. Do you feel that you did better on the second demonstration?	3	7
10. Do you think that this micro-teaching experience took you away from class too much?	10	0
11. Do you feel that this micro-teaching experience was worth being away from class as much as you were?	0	10
12. Do you think that the micro-classes were fair when they evaluated your demonstrations?	0	10
13. Did the second trial of each demonstration follow too soon after the first trial of each demonstration?	5	5
14. Did you feel reluctant to present the second trial of each demonstration?	6	4
15. Did you feel uncomfortable presenting demonstrations to friends in the class?	10	0
16. Do you think that having the experience of presenting the first demonstration helped you prepare for the second demonstration?	0	10
17. Do you think that this experience with micro-teaching will help you during student teaching?	1	9

TABLE 7

RESPONSES TO THE QUESTIONNAIRE BY STUDENTS IN THE MICRO-CLASSES

	Undergraduate Students				Graduate Students			
Question	No	%	Yes	%	No	%	Yes	%
1. Do you think that the presence of the experimenter affected the way you evaluated the demonstrations?	30	97	1	3	11	100	0	0
2. Do you think that the presence of the video recording equipment affected the way you evaluated the demonstrations?	30	97	1	3	11	100	0	0
3. Do you think that the presence of the person who presented the demonstrations affected the way you marked the evaluation sheets at the conclusion of the presentation?	21	68	10	32	11	100	0	0
4. Did you feel uncomfortable evaluating demonstrations presented by friends in the class?	27	87	4	13	9	82	2	18
5. Do you think that this micro-teaching experience took you away from class too much?	20	65	11	35	11	100	0	0
6. Do you feel that this micro-teaching experience was worth being away from class as much as you were?	5	16	26	84	1	9	10	91
7. Do you think that this experience with micro-teaching will help you during student teaching?	10	32	21	68				

TABLE 8

EVALUATION SCORES OF DEMONSTRATIONS PRESENTED BY STUDENT TEACHERS

Group	Teacher	Scores			Mean
A	1	36	30	34	33.3
A	21	28	30	28	28.7
A	22	42	45	36	41.0
A	23	33	37	41	37.0
A	24	42	41	32	38.3
A	51	30	31	30	30.3
A	52	23	25	24	24.0
A	53	35	43	30	36.0
A	81	31	30	43	34.7
A	82	38	37	34	36.3
B	26	30	27	35	30.7
B	27	35	39	37	37.0
B	28	36	36	38	36.7
B	29	27	24	34	28.3
B	30	39	46	43	42.7
B	69	26	30	30	28.7
B	70	33	37	35	35.0
B	88	38	38	41	39.0
B	91	40	45	37	40.7
B	93	44	46	49	46.3
C	31	27	26	41	31.3
C	33	25	27	29	27.0
C	34	27	35	41	34.3
C	89	32	32	37	33.7
C	101	29	34	27	30.0
C	61	25	29	39	31.0
C	66	25	20	33	26.0
C	129	34	36	34	34.7
C	126	31	36	30	32.3
C	121	28	34	23	28.3

TABLE 9

CORRELATION COEFFICIENTS OF RESPONSES TO QUESTIONS ON THE DEMONSTRATION FORMS USED TO EVALUATE STUDENT TEACHERS

Question	1	2	3	4	5	6	7	8	9	10	Σ
1	1.00	0.46	0.40	0.36	0.41	0.48	0.39	0.45	0.51	0.55	0.72
2		1.00	0.70	0.36	0.28	0.35	0.43	0.51	0.46	0.59	0.74
3			1.00	0.15	0.31	0.32	0.46	0.36	0.48	0.52	0.67
4				1.00	0.23	0.41	0.23	0.46	0.43	0.42	0.59
5					1.00	0.37	0.36	0.28	0.30	0.22	0.52
6						1.00	0.58	0.43	0.48	0.56	0.71
7							1.00	0.39	0.47	0.56	0.69
8								1.00	0.58	0.56	0.72
9									1.00	0.74	0.78
10										1.00	0.81
Σ											1.00

TABLE 10

MEANS AND STANDARD DEVIATIONS OF RESPONSES TO QUESTIONS ON THE DEMONSTRATION EVALUATION FORMS USED TO EVALUATE STUDENT TEACHERS

Question	Mean	Standard Deviation
1	3.04	0.91
2	3.39	0.94
3	3.79	0.86
4	3.33	0.97
5	3.87	0.86
6	3.23	0.95
7	3.10	0.81
8	3.48	0.88
9	3.24	0.96
10	3.26	0.89
Σ	33.78	6.27

Justified by this relatively high reliability coefficient and the positive values in the correlation matrix, the mean scores of the three evaluations for each student teacher were used as the dependent variables in an analysis of covariance study. Groups A, B, and C were defined as the treatment groups, and the covariates were each student teacher's grade point average in his major teaching area, his overall college grade point average, and his rating on the Rokeach Dogmatism Scale. The means of the three covariates along with the treatment means and the adjusted means of the dependent variable are presented in Table 11. The analysis of covariance table is presented in Appendix I.

TABLE 11

MEANS OF THE COVARIATES, TREATMENT MEANS AND ADJUSTED MEANS OF THE DEPENDENT VARIABLE FOR GROUPS A, B, AND C

Group	Grade point average in major area	Overall college grade point average	Rokeach Dogmatism rating	Treatment means	Adjusted means
A	2.99	3.03	138.6	33.96	33.73
B	2.83	2.94	145.1	36.51	36.61
C	2.92	2.95	142.0	30.86	30.99

The resulting value of F was 3.597. With two and twenty-four degrees of freedom this was significant at the 0.05 level. Therefore, the null hypothesis that there would be no significant difference in effectiveness among the three groups of student teachers was rejected.

One additional statistical test was made. When the mean evaluation score of the fifteen more dogmatic student teachers was compared with the mean evaluation score of the fifteen less dogmatic student teachers the resulting value of t was 0.517 which, with fourteen degrees of freedom, is not significant at the 0.05 level or at the 0.10 level. Therefore, the null hypothesis that there would be no significant difference in effectiveness between the more dogmatic and the less dogmatic student teachers was not rejected.

Summary

To summarize the results of the study, the hypotheses will be restated, and the statistical evidence used to reject or not reject these hypotheses will be presented.

1-a. During the micro-teaching sessions, there would be no significant difference in the effectiveness with which each teacher would present the first and second trials of the twenty demonstrations. The calculated value of t was 1.38 which, with nineteen degrees of freedom, was not significant at the 0.05 level. The hypothesis was not rejected.

Separate tests of the first and second demonstrations produced different results. The value of t calculated for the difference between the means of the first and second trials of the first demonstration was - 0.89. With nine degrees of freedom, this was not significant at the 0.05 level. The value of t calculated for the difference between the means of the first and second trials of the second demonstration was 2.68. With nine degrees of freedom, this was significant at the 0.05 level.

1-b. During the micro-teaching sessions, there would be no significant difference in the effectiveness with which each teacher would present the second trial of the first demonstration and the second trial of the second demonstration. The calculated value of t was 3.68 which, with nine degrees of freedom, was significant at the 0.05 level. Therefore the hypothesis was rejected.

2. During part two of the study there would be no significant difference in the effectiveness with which student teachers in Groups A, B, and C would present demonstrations to their secondary school science classes. The analysis of covariance resulted in a value of F which was 3.597. With two and twenty-four degrees of freedom this was significant at the 0.05 level. The hypothesis was rejected.

3. During part two of the study there would be no significant difference in the effectiveness with which the fifteen most dogmatic student teachers and the fifteen least dogmatic teachers would present demonstrations to their secondary school science classes. The calculated value of t was 0.517 which, with fourteen degrees of freedom, was not significant at the 0.05 level. Therefore, this final hypothesis was not rejected.

The tests of the hypotheses and other results of the study, along with the conclusions, will be discussed in Chapter V.

CHAPTER V

DISCUSSION OF RESULTS AND CONCLUSIONS

Introduction

The results of the study will be discussed in the order in which they were presented in Chapter IV. Results of the micro-teaching sessions will be discussed and tentative conclusions will be stated. The results of the student teaching phase of the study will be discussed next, followed by the results of the administration of the Rokeach Dogmatism Scale.

Micro-Teaching Sessions

Each of the ten students in Group A presented two trials of two demonstrations to micro-classes composed of peers. Each trial of each demonstration was evaluated by four peers using a demonstration evaluation form developed by the investigator.

Hypothesis 1-a.

The null hypothesis predicting no significant change in effectiveness between the first and second trials of the twenty demonstrations was not rejected. When the first and second demonstrations presented by each teacher were tested separately, however, the results were slightly different. There was no significant change between the first and second trials of the first demonstration. There was a significant increase in effectiveness between the first and second trials of the second demonstration.

No positive evidence for the lack of change between trials of the first demonstration was identified by the study. However, the responses to the questionnaire by the students in Group A and observations made by the investigator strongly support the following tentative reasons.

It was the opinion of five of the students in Group A that there was insufficient time between the first and second trials of a demonstration. It is the opinion of the investigator that this lack of time is basically the most important reason for the lack of significant change. This opinion is based on the following observations made during the micro-teaching sessions.

If a teacher was not able to answer specific questions asked during the first trial, he usually could not answer the same questions if they were asked during the second trial. The ten to fifteen minutes between trials was not enough time to find answers. Occasionally, a student in the micro-class for trial one would know the answer, or the teacher would ask the investigator during the break between trials. In general, however, there was not enough time for the teachers to find the answers to questions they could not answer during the first trial.

If the apparatus did not operate correctly during the first trial, there was not enough time to make more than superficial changes. There was barely enough time to make substitutions of auxiliary equipment and supplies such as power supplies, chemicals, etc. If the teacher had to substitute equipment between trials (e.g. a power supply for dry cells no longer usable) and the teacher did not know how to use the substitute equipment, the few minutes between trials was not usually sufficient time to learn the new technique.

The teacher may have practiced using the apparatus several times, but not realized until the day of the presentation that he did not understand the science content involved. In this case there was absolutely not enough time between trials to attempt to solve this problem.

Hypothesis 1-b.

The null hypothesis predicting no significant change in effectiveness between the second trial of the first demonstration and the second trial of the second demonstration was rejected. Where the first hypothesis was proposed to test for a change in effectiveness between trials, the purpose of this hypothesis was to test for a change in effectiveness between demonstrations.

The decision to test for a change in effectiveness between the second trials of the two demonstrations was basically an arbitrary one. It was the opinion of the investigator that the second trial of each demonstration would provide as valid a reference point as the first trial of each demonstration.

Conclusions

Based on the preceding results of the micro-teaching phase of the study, the following conclusions were reached:

1. The technique of micro-teaching, as utilized in this study, did not result in a significant increase in effectiveness between the first and second trials of the first demonstration presented by each teacher.

2. There was a significant increase in effectiveness between the first and second trials of the second demonstration presented by each teacher in Group A.

3. Since the micro-teaching technique resulted in a greater increase in effectiveness between the first and second trials of the second demonstration than between the first and second trials of the first demonstration, its value increased with each demonstration presented.

Responses to the Questionnaire by Group A.

In general, the reaction of this group to micro-teaching was very favorable. Areas in which there was disagreement will be discussed, and the students' comments will be included where pertinent.

Six of the teachers stated that they were uncomfortable because there were experienced teachers in the micro-classes. The two reasons stated most often were: they were afraid that the experienced teachers would be too critical of their presentations, and they were afraid the experienced teachers would ask questions they could not answer.

The three teachers who were uncomfortable because of the peers in the class were among the six mentioned above. One made the comment that he would have been uncomfortable presenting a demonstration to any group. The investigator tends to agree, noting that this teacher is the only one who felt uncomfortable because the investigator was in the room during the presentations. The others classified the investigator along with the video equipment. Once the presentation had begun, they forgot it was in the room.

Nine of the teachers stated that the verbal critiques had helped them prepare for the second trial of each demonstration. Seven of the teachers stated that the evaluation form had helped them prepare for the second trial of each demonstration. Two of the teachers who felt it had not, added the comment that there was not enough time to do anything about the weak areas revealed on the forms. The third felt that the verbal critiques were more helpful than the evaluation forms.

Of the four teachers who were reluctant to present the second trial of each demonstration, one wanted more time to prepare, one was afraid he would do worse the second trial, one had no precise reason, and one commented that he just wanted to get the demonstration over with.

In addition to the responses to the questionnaire, the investigator received several favorable, unsolicited, verbal comments from the teachers in Group A. Since participation in the study was voluntary, there was no reason to doubt the sincerity of the comments. A typical comment was that although the person was apprehensive before presenting the first demonstration, he felt that the micro-teaching experience had been a very valuable one. Others stated that they had enjoyed working with the small classes.

The conclusion, based upon these written and oral comments, was that the students in Group A had reacted very favorably to the micro-teaching experience.

Responses to the Questionnaire by Students in the Micro-Class

With the exception of two questions, the graduate students were unanimous in their replies to the questionnaire. Two graduate students felt uncomfortable evaluating demonstrations presented by peers, one because the group he was in seemed shy, and the other because he felt inadequate. One of the graduate students stated that the micro-teaching experience was not worth being away from class as much as he had been.

The undergraduate students did not agree on as many of the questions as did the graduate students. Ten of the undergraduate students felt that the presence of the teacher affected the way they marked the evaluation forms. Two of them were afraid that they rated the presentation too high to avoid creating hard feelings. (An examination of the evaluatinn forms of the other students revealed that this was not true.) Two of them felt uncomfortable only at first. Two were afraid the teacher would watch them marking the form, and the other four were just uncomfortable. Only four of the undergraduate students felt uncomfortable evaluating demonstrations presented by friends. One would have preferred evaluating a stranger, one was afraid the teacher would see the evaluation form, and the other two were just uncomfortable.

Eleven of the students thought they were away from class too much. The reasons given can be divided into four categories. Four of the students said that they did not have time to make up work missed, three said that they missed important discussions, two said that they would rather have participated outside the regular classtime, and two said it was lost time for them.

Five students stated that the micro-teaching sessions were not worth being away from class as much as they were. The basic reason stated by these five students was that they were out of class too much. It is interesting to note that seven of the eleven teachers who answered yes to the preceding question decided that the micro-teaching experience was worth being away from class.

Ten students did not think that the micro-teaching experience would help them during student teaching. Three of the students did not think they had participated in enough micro-classes, three thought they would have been helped if they had been the teacher, three gave no specific reason, and the last was planning to student teach in Spanish rather than in science.

At the time the investigator gave the questionnaires to the students, he told them that whatever their feelings about their micro-teaching experiences were, they would be of greatest service to the study by being honest when answering the questions. They were also told that only a summary of their answers would be given to the instructors of the laboratory practicums. Based on their frank and sometimes uncomplimentary comments, it is the opinion of the investigator that the students had answered the questions as honestly as they could. Taking the adverse comments into consideration, the investigator concluded that the majority of the students in the micro-classes, along with the students in Group A, had reacted very favorably to their micro-teaching experiences.

General Comments on Micro-Teaching

The following general comments on micro-teaching are based on observations made by the investigator during part one of the study. The topics discussed do not have a direct relationship with the hypothesis tested in the study, but are closely associated with the technique of micro-teaching as it was utilized in this study.

Demonstration Topics

The investigator asked the teachers in Group A to present demonstrations which would provide a learning experience for the college students in the micro-classes. They could present a demonstration to teach the students how to present a demonstration at the secondary school level, but they were specifically asked not to present their demonstration at the secondary school level. This was done to exclude play acting on the part of the micro-classes.

It is the opinion of the investigator that the teachers were successful in following these instructions. Although the students had seen many of the demonstrations before, they did not necessarily understand the scientific principles involved. Moreover, approximately one third of the demonstrations were new to the graduate students in the micro-classes. The nature of the questions asked by the students tends to substantiate the investigator's opinion that the demonstrations did provide a valid learning experience.

Verbal Critique

The investigator had the opportunity to teach the Practicum in General and Physical Science for Teachers prior to conducting this study. As one of the requirements of the course, each student would present a demonstration to the class. A form similar to the one used in this study was used by the students to evaluate the presentation. Following each demonstration the class was given the opportunity to verbally critique the presentation. More often than not this was unsuccessful. It appeared that the students were reluctant to make even constructive criticism when there was a possibility that the instructor would consider this in his evaluation. If this occurred early in the quarter many of the students knew that they too would be in the position to be critiqued.

Within the small group atmosphere of the micro-classes and in the absence of the instructor of the course, the students seemed to lose many of their inhibitions and became definitely more open in their verbal critiques. The students seemed to realize that their verbal critique would be helpful to the teacher only if they were completely honest. In turn, the teachers accepted the criticism in the manner in which it was given.

Part Two

During part two of the study the thirty student teachers in Groups A, B, and C presented demonstrations to their secondary school science classes. Each student teacher planned a demonstration which could be completed in one class period. Each demonstration was to be presented at a time when it would fit logically into the normal order of teaching. Each presentation was evaluated by the investigator and two other persons. The mean of the three evaluations for each student teacher was the dependent variable in an analysis of covariance study. The covariates were the student teacher's grade point average in his major area of teaching, his overall college grade point average, and his score on the Rokeach Dogmatism Scale. The results of this analysis were used to test Hypothesis 2.

Hypothesis 2.

The null hypothesis which stated that there would be no significant difference in the effectiveness with which the student teachers in Groups A, B, and C would present demonstrations to their secondary school science classes was rejected.

An examination of the results of the analysis of covariance study presented in Table 11 reveals that the covariates had very little effect on the treatment means. This is an indication that with or without the effects of the covariates there would have been a significant difference between the three groups.

The order of difference between the groups was not as expected. The student teachers in Group B were rated significantly higher than the student teachers in Group A. More in accord with the expected results of the study, the students in Groups A and B were rated significantly higher than the students in Group C.

Thus, both groups of student teachers who had participated in the micro-teaching phase of the study were rated significantly higher than the group who had not participated. The first conclusion was that the student teachers in Groups A and B had received some benefit from the micro-teaching experience.

The ten student teachers in Group B, each of whom had participated in at least four micro-classes, were rated significantly higher than the ten student teachers in Group A who had presented the demonstrations. The second conclusion was that micro-teaching technique, as utilized in this study, was more beneficial to the students who were members of the micro-classes than to the students who presented the demonstrations.

An examination of the data collected in the study does not provide evidence to explain why the micro-teaching experience was more beneficial to the student teachers in Group B than to those in Group A.

Each student teacher in Group A had presented two trials of two demonstrations. Each presentation was verbally critiqued by the micro-class. Each presentation was also evaluated by the micro-class using the demonstration evaluation form. Each teacher was able to view the video-recordings of the first trials two times and the video-recordings of the second trials one time. The teachers were allowed to examine the completed evaluation forms while watching the video-recordings. Although the investigator constantly stressed the importance of self evaluation he was present when the teachers were viewing the video recordings and he helped the teachers recognize their weak areas. The investigator also made sure that the teachers were aware of their strong areas.

Each of the student teachers in Group B participated in at least four presentations. They were instructed before each presentatinn to observe specific areas in order to answer the questions on the evaluation forms. They were also instructed to be prepared to verbally critique the presentation when it was completed.

It is the opinion of the investigator that a combination of factors made the student teachers in Group B more aware of the criteria of an effective demonstration than were the student teachers in Group A.

These factors were participating in four or more micro-classes as students, verbally critiquing each presentation, and using the demonstration evaluation form to evaluate each of the presentations. This increased awareness could have been responsible for the student teachers in Group B presenting demonstrations more effectively than the student teachers in Group A.

Implication for Teacher Education

Although this study was conducted with a relatively small sample, it is the opinion of the investigator that the results clearly contain an implication for teacher education. While it is important that prospective teachers be given as many opportunities as possible to teach, it is equally important that they be given opportunities to observe and evaluate other teachers. This latter experience becomes more valuable when the observer is given specific guidelines to follow while making the evaluations. This experience also becomes more valuable when it is conducted in the small group atmosphere of the micro-class.

Hypothesis 3.

The Rokeach Dogmatism Scale Form E was administered to the thirty student teachers in Groups A, B, and C. Groups A, B, and C were chosen before the Dogmatism Scale was administered, and the student teachers had presented their demonstrations before the scales were scored. When the final results were tabulated it was discovered that each of the three groups contained five of the most dogmatic and five of the least dogmatic student teachers.

The mean scores for the three groups were reported in Table 11. Group B, with a mean score of 145.1, was the most dogmatic; Group A, with a mean score of 138.6, was least dogmatic; and Group C, with a mean score of 142.0, was in between the other two. The overall mean for the thirty student teachers was 141.93.

The hypothesis which stated that there would be no significant difference in the effectiveness with which the fifteen most dogmatic student teachers and the fifteen least dogmatic student teachers would present demonstrations to their secondary school science classes was not rejected. Since the statistical test yielded a non-significant result, it was concluded that the degree to which the student teachers who participated in this study had open or closed minds did not have a significant effect on the effectiveness with which they presented demonstrations to secondary school science classes.

One additional comment seems pertinent to this topic. Eighteen of the student teachers had scores within fifteen points above and fifteen points below the mean--that is, between 127 and 157. One student teacher was very dogmatic (198); one student teacher was very open minded (99). Both of these student teachers were in Group A. Without a large population from which groups of open minded and closed minded subjects can be selected, it is unlikely that any difference in effectiveness could be measured.

Demonstration Evaluation Forms

In Tables 5 and 10, the means for each of the questions on the two groups of evaluation forms were reported. When these means were ranked from low to high, the three weakest areas of the micro-teaching presentations were the introduction, the way the teacher answered student questions, and the questions the teacher asked. The three weakest areas of the student teaching presentations were the same three areas, ranked in the same order.

The Kuder-Richardson reliability coefficient for the demonstration evaluation forms used in the micro-teaching phase of the study was 0.844. The reliability coefficient for the forms used to evaluate student teachers was 0.879. Although the reliability is slightly higher for the student teaching forms, the difference does not appear to be large enough to be meaningful.

Review of Conclusions

Before summarizing the study, the conclusions will be restated. They are:

1. The technique of micro-teaching, as utilized in this study, did not result in a significant increase in effectiveness between the first and second trials of the first demonstration presented by each teacher.

2. There was a significant increase in effectiveness between the first and second trials of the second demonstration presented by each teacher in Group A.

3. Since the micro-teaching technique resulted in a greater increase in effectiveness between the first and second trials of the second demonstration than between the first and second trials of the first demonstration, its value increased with each demonstration presented.

4. The majority of the students in Groups A and B reacted very favorably to their micro-teaching experiences.

5. The student teachers in Groups A and B received some benefit from the micro-teaching experience.

6. The micro-teaching technique, as utilized in this study, was more beneficial to the students who were members of the micro-classes than to the students who presented the demonstrations.

7. The degree to which the student teachers who participated in this study had open or closed minds did not have a significant effect on the effectiveness with which they presented demonstrations to secondary school science classes.

Summary

This study was conducted within the framework of regularly scheduled science methods courses. Because of the amount of time involved for the students in both Groups A and B, a compromise was made at the time the size of the groups was determined. The investigator is aware that the reliability of a study increases with the size of the sample involved. If the number of students in each group had been increased, it would have been necessary to reduce the amount of micro-teaching experience for each student in Group A. It would also have been necessary to increase the number of times that each student in Group B participated in micro-classes or to reduce the number of students in each micro-class.

It is the opinion of the investigator that a satisfactory compromise was attained, and that the significant results of the study justify the utilization of this micro-teaching technique in future research.

There are questions that remain unanswered. The investigator can only speculate as to the benefits the students in Group A might have derived had they presented more than two demonstrations or more than two trials of each demonstration. Would there have been a more significant difference in effectiveness between the first and second trial of each demonstration if the teachers in Group A had been given a longer period of time between the two trials to replan their presentations. Would the student teachers in Group B have been able to present demonstrations more effectively had they participated in additional micro-teaching sessions. Would the students in both Groups A and B have received additional benefits if the micro-teaching sessions had included teaching and participation in micro-classes for both groups. Finally, the most important question raised as a result of the study is why the micro-teaching experience was more beneficial to the student teachers in Group B than to those in Group A.

APPENDIX A

COURSE DESCRIPTIONS

COURSE DESCRIPTIONS

These course descriptions were taken from Book 14 of the 1967-68 Announcement Series titled University Academic Policies and Offerings, The Ohio State University.

Education 551-Science in Secondary Schools:

Objectives, problems and procedures, preparing teaching plans, use of demonstrations, experiments, and projects, science curriculum and evaluation, instruments and procedures, texts and reference materials.

Education 587.27-Student Teaching in Secondary Schools-Science:

Observation, participation, and responsible teaching in a public school in the greater Columbus area. Individual and group conferences or seminars.

Education 625-Practicum in Biological Science for Teachers:

Use and design of apparatus, demonstrations and experiments; collection and preservation of biological materials; the role of the living organism in the classroom.

Education 627-Practicum in General and Physical Science for Teachers:

Use and design of apparatus, demonstrations, and experiments for general science, chemistry and physics, with special emphasis on modern secondary school instructional materials in the sciences.

APPENDIX B

DEMONSTRATION EVALUATION FORM USED IN PART ONE OF THE STUDY

DEMONSTRATION EVALUATION

Teacher_____________________________

Subject_____________________________

Date _____________________________

	Very Superior	Strong	Good	Fair	Unsatisfactory
1. The teacher's introduction to the demonstration helped me become interested in the demonstration.	5	4	3	2	1
2. I could understand the operation of the apparatus used in the demonstration.	5	4	3	2	1
3. The teacher knew how to use the apparatus.	5	4	3	2	1
4. I could see the demonstration.	5	4	3	2	1
5. I could hear the teacher.	5	4	3	2	1
6. The questions the teacher asked during the demonstration made me think.	5	4	3	2	1
7. The way the teacher answered student questions helped me understand the demonstration.	5	4	3	2	1
8. The demonstration was paced so that I could follow the development of the demonstration.	5	4	3	2	1
9. I understood the purpose of the demonstration by the time it was completed.	5	4	3	2	1
10. The demonstration helped me understand the topic (fact, principle, concept, generalization, etc.) we are studying.	5	4	3	2	1

APPENDIX C

ROKEACH DOGMATISM SCALE, FORM E

PUBLIC OPINIONNAIRE

DIRECTIONS

The following is a study of what the general public thinks and feels about a number of important social and personal questions. The best answer to each statement is your personal opinion. We have tried to cover many different and opposing points of view; you may find yourself agreeing strongly with some of the statements, disagreeing just as strongly with others, and perhaps uncertain about others. Whether you agree or disagree with any statement, you can be sure that many people feel the same as you do.

Mark each statement in the appropriate space on the answer blank according to how much you agree or disagree with it. Please mark evey one.

Write +1, +2, +3, or -1, -2, -3, depending on how you feel in each case.

+1	I AGREE A LITTLE	-1	I DISAGREE A LITTLE
+2	I AGREE ON THE WHOLE	-2	I DISAGREE ON THE WHOLE
+3	I AGREE VERY MUCH	-3	I DISAGREE VERY MUCH

You may have as much time as you need, so please read each statement very carefully.

1. The United States and Russia have just about nothing in common.

2. The highest form of government is a democracy and the highest form of democracy is a government run by those who are most intelligent.

3. Even though freedom of speech for all groups is a worthwhile goal, it is unfortunately necessary to restrict the freedom of certain political groups.

4. It is only natural that a person would have a much better acquaintance with ideas he believes in than with ideas he opposes.

5. Man on his own is a helpless and miserable creature.

6. Fundamentally, the world we live in is a pretty lonesome place.

7. Most people just don't give a "damn" for others.

8. I'd like it if I could find someone who would tell me how to solve my personal problems.

9. It is only natural for a person to be rather fearful of the future.

10. There is so much to be done and so little time to do it in.

11. Once I get wound up in a heated discussion I just can't stop.

12. In a discussion I often find it necessary to repeat myself several times to make sure I am being understood.

13. In a heated discussion I generally become so absorbed in what I am going to say that I forget to listen to what the others are saying.

14. It is better to be a dead hero than to be a live coward.

15. While I don't like to admit this even to myself, my secret ambition is to become a great man, like Einstein, or Beethoven, or Shakespeare.

16. The main thing in life is for a person to want to do something important.

17. If given the chance I would do something of great benefit to the world.

18. In the history of mankind there have probably been just a handful of really great thinkers.

19. There are a number of people I have come to hate because of the things they stand for.

20. A man who does not believe in some great cause has not really lived.

21. It is only when a person devotes himself to an ideal or cause that life becomes meaningful.

22. Of all the different philosophies which exist in this world there is probably only one which is correct.

23. A person who gets enthusiastic about too many causes is likely to be a pretty "wishy-washy" sort of person.

24. To compromise with our political opponents is dangerous because it usually leads to the betrayal of our own side.

25. When it comes to differences of opinion in religion we must be careful not to compromise with those who believe differently from the way we do.

26. In times like these, a person must be pretty selfish if he considers primarily his own happiness.

27. The worst crime a person could commit is to attack publicly the people who believe in the same thing he does.

28. In times like these it is often necessary to be more on guard against ideas put out by people or groups in one's own camp than by those in the opposing camp.

29. A group which tolerates too much differences of opinion among its own members cannot exist for long.

30. There are two kinds of people in this world: those who are for the truth and those who are against the truth.

31. My blood boils whenever a person stubbornly refuses to admit he's wrong.

32. A person who thinks primarily of his own happiness is beneath contempt.

33. Most of the ideas which get printed nowadays aren't worth the paper they are printed on.

34. In this complicated world of ours the only way we can know what's going on is to rely on leaders or experts who can be trusted.

35. It is often desirable to reserve judgment about what's going on until one has had a chance to hear the opinions of those one respects.

36. In the long run the best way to live is to pick friends and associates whose tastes and beliefs are the same as one's own.

37. The present is all too often full of unhappiness. It is only the future that counts.

38. If a man is to accomplish his mission in life it is sometimes necessary to gamble "all or nothing at all."

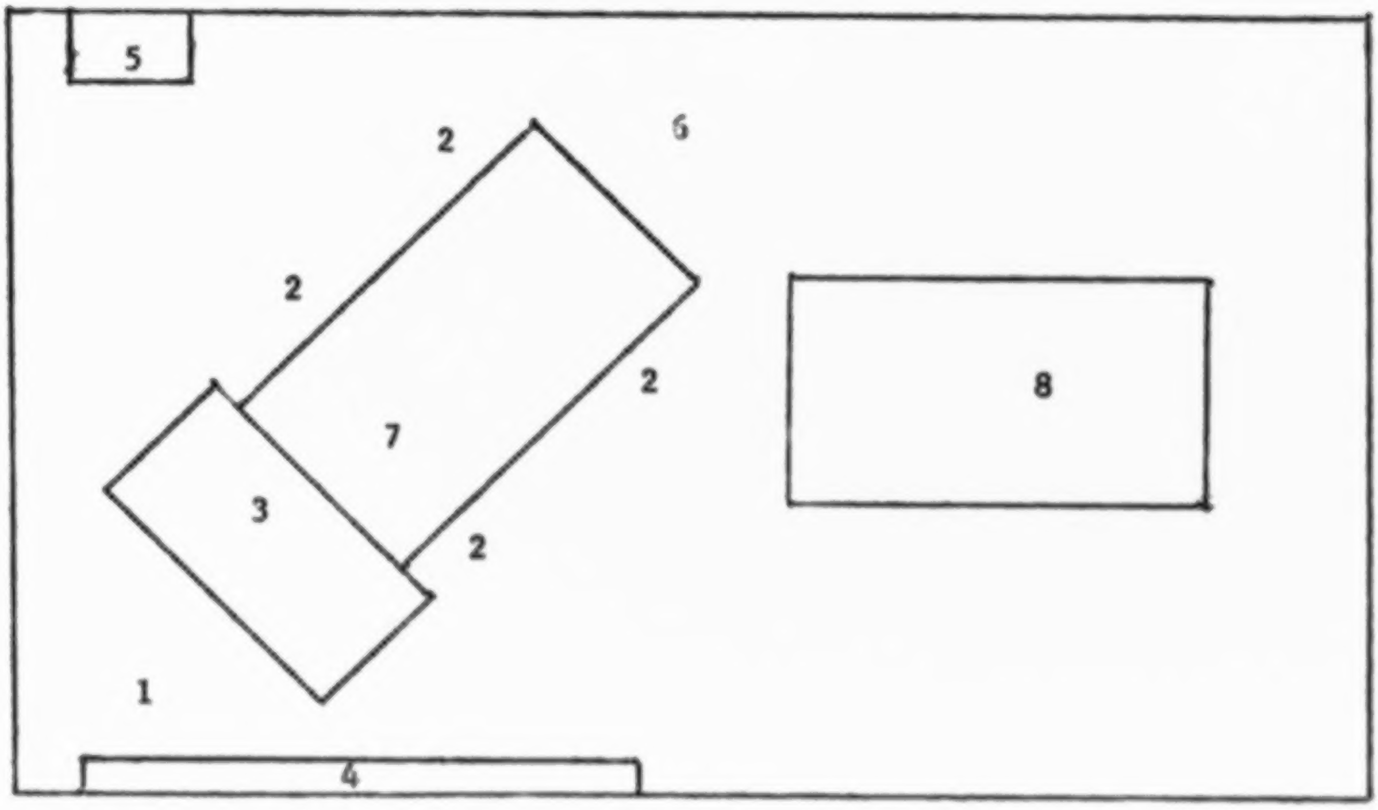
39. Unfortunately, a good many people with whom I have discussed important social and moral problems don't really understand what's going on.

40. Most people just don't know what's good for them.

APPENDIX D

ROOM ARRANGEMENT FOR MICRO-TEACHING

ROOM ARRANGEMENT FOR MICRO-TEACHING



1. Teacher
2. Micro-class
3. Demonstration table
4. Chalk board
5. Sink with hot and cold water
6. Video camera
7. Microphone suspended from ceiling
8. Video recorder and monitor

APPENDIX E

VIDEO TAPE RECORDING RELEASE AND WAIVER

THE OHIO STATE UNIVERSITY
SCHOOL OF EDUCATION
SCIENCE EDUCATION AREA

VIDEO TAPE RECORDING RELEASE AND WAIVER

(1) I, the undersigned, hereby grant the School of Education of The Ohio State University, and Daniel Goldthwaite, permission to make video tape recordings, separately or in combination, of me, and I also give the School of Education and Daniel Goldthwaite permission to put the finished video tape recordings to any uses they may deem proper.

(2) Further, for full consideration, receipt of which I acknowledge, I do hereby relinquish and give to the School of Education and Daniel Goldthwaite all right, title, and interest in and to, and income from, the finished video tape recordings, grant the School of Education and Daniel Goldthwaite to give, sell, transfer, and exhibit the same to any individual or class without any payment or other consideration to me.

(3) My agreement to perform under camera, lighting, and stage conditions is voluntary and I do hereby waive all personal claims, causes of action, or damages against the School of Education, The Ohio State University, and Daniel Goldthwaite arising from or growing out of my said performance or appearance.

Signed________________________

Address_______________________

Date____________At__________

Witness_______________________

____

For the School of Education
The Ohio State University

APPENDIX F

QUESTIONNAIRES FOR GROUP A AND FOR STUDENTS IN THE MICRO-CLASSES

GROUP A Number_____

1. Do you believe that the presence of the video recording equipment affected the presentation of your first demonstration to the micro-class? No_____ Yes_____ If so please explain- (After each question, space was provided for explanation if needed.)

2. Do you believe that the presence of the video recording equipment affected the presentation of your second demonstration? No_____ Yes_____ If so please explain-

3. Did the presence of the experimenter make you feel uncomfortable? No_____ Yes_____ If so please explain-

4. Did you feel uncomfortable because there were experienced teachers in the micro-classes? No_____ Yes_____ If so please explain-

5. Did you feel uncomfortable presenting demonstrations to a peer group? No_____ Yes_____ If so please explain-

6. Do you think that the demonstration evaluation sheets helped you prepare for the second trial of each demonstration? No_____ Yes_____ Please elaborate-

7. Do you think that the verbal critiques helped you prepare for the second trial of each demonstration? No_____ Yes_____ Please elaborate-

8. Do you feel that you did better on the reteaches? No_____ Yes_____ Please explain-

9. Do you feel that you did better on the second demonstration? No_____ Yes_____ Please explain-

10. Do you think that this micro-teaching experience took you away from class too much? No_____ Yes_____ Please explain-

11. Do you feel that this micro-teaching experience was worth being away from class as much as you were? No_____ Yes_____ Please explain-

12. Do you think that the micro-classes were fair when they evaluated your demonstrations? No_____ Yes_____ Please explain-

13. Did the second trial of each demonstration follow too soon after the first trial of each demonstration? No_____ Yes_____ Please explain-

14. Did you feel reluctant to present the second trial of each demonstration? No_____ Yes_____ Please explain-

15. Did you feel uncomfortable presenting demonstrations to friends in the class? No_____ Yes_____ Please explain-

16. Do you think that having the experience of presenting the first demonstration helped you prepare for the second demonstration? No_____ Yes_____ Please explain-

17. Do you think that this experience with micro-teaching will help you during student teaching? No_____ Yes_____ Please explain-

If I have neglected some topic which you feel is important, will you please use the remainder of this page to discuss it. Any constructive criticism will be appreciated.

MICRO-CLASS STUDENTS Number________

1. Do you think that the presence of the experimenter affected the way you evaluated the demonstrations? No_____ Yes_____ Please explain-
   (After each question space was provided for explanation if needed.)
2. Do you think that the presence of the video recording equipment affected the way you evaluated the demonstrations? No_____ Yes____ Please explain-
3. Do you think that the presence of the person who presented the demonstrations affected the way you marked the evaluation sheets at the conclusion of the presentation? No_____ Yes_____ Please explain-
4. Did you feel uncomfortable evaluating demonstrations presented by friends in the class? No_____ Yes_____ Please explain-
5. Do you think that this micro-teaching experience took you away from class too much? No_____ Yes_____ Please explain-
6. Do you feel that this micro-teaching experience was worth being away from class as much as you were? No_____ Yes_____ Please explain-
7. Do you think that this experience with micro-teaching will help you during student teaching? No_____ Yes_____ Please explain-

If I have neglected some topic which you feel is important, will you please use the remainder of this page to discuss it. Any constructive criticism will be appreciated.

APPENDIX G

DEMONSTRATION EVALUATION FORM USED IN PART TWO OF THE STUDY

DEMONSTRATION EVALUATION FORM

STUDENT TEACHER______________________________SCHOOL______________

ROOM______________DATE______________TIME_________SUBJECT________

DEMONSTRATION TOPIC____

EVALUATOR__________________________

COOPERATING TEACHER________________

		Very Superior	Strong	Good	Fair	Unsatisfactory
1.	The teacher's introduction to the demonstration seemed to help the students become interested in the demonstration.	5	4	3	2	1
2.	The students seemed to understand the operation of the apparatus used in the demonstration.	5	4	3	2	1
3.	The teacher knew how to use the apparatus.	5	4	3	2	1
4.	The students could see the demonstration.	5	4	3	2	1
5.	The students could hear the teacher.	5	4	3	2	1
6.	The questions the teacher asked during the demonstration seemed to make the students think.	5	4	3	2	1
7.	The way the teacher answered students' questions seemed to help the students understand the demonstration.	5	4	3	2	1
8.	The demonstration was paced so that the students could follow the development of the demonstration.	5	4	3	2	1
9.	The students seemed to understand the purpose of the demonstration by the time it was completed.	5	4	3	2	1
10.	The demonstration seemed to help the students understand the topic (fact, principle, concept, generalization, etc.) they were studying.	5	4	3	2	1

APPENDIX H

SUMMARIES OF DEMONSTRATIONS

SUMMARIES OF DEMONSTRATIONS

The demonstrations presented in the micro-teaching sessions of part one of the study are summarized in this appendix. The student who presented the demonstration is identified by number only and is referred to as the teacher. The subjects who composed the micro-class are called the students.

Teacher Number 1: Demonstration 1.

The purpose of this demonstration was to show and compare two methods of determining the percentage of oxygen in air. As stated in the objectives the students were to be able at the completion of the demonstration to compare the two methods with respect to which method would give the more accurate results. To show the first method the teacher attached a burning candle to a cork floating on water, then inverted a graduated cylinder over the candle, sealing the candle in a fixed amount of air. When the candle stopped burning the teacher measured the change in the volume of air. For the second method the teacher sealed a small quantity of burning red phosphorus in a fixed volume of air, then measured the change in volume.

There were two main weaknesses in the presentation. The teacher started the demonstration with practically no introduction. This was very confusing to the students, especially those who were not familiar with the apparatus. Secondly, the teacher did not answer student questions very well. Based on the type of questions asked this seemed to indicate that the teacher did not thoroughly understand the concepts involved.

On the positive side, the teacher's enthusiasm did carry the group through the weak introduction, and by the time the demonstration was completed they did seem to understand the purpose of the demonstration.

The second trial proceeded very similarly to the first. Although the teacher tried to improve the introduction, it was not much more successful than in the first trial. Many of the student questions which the teacher could not answer the first trial were also asked during the second trial. With insufficient time between trials to study the science content involved, the teacher still could not answer them.

Teacher Number 1: Demonstration 2.

The topic of the second demonstration was chemical equilibrium and LeChatelier's principle. As stated in the objectives, the students should be able, at the completion of the demonstration, to list and define the characteristics of chemical equilibrium and explain the effect of stress on a system at equilibrium. The teacher demonstrated the process using several chemical reactions involving color changes easily visible to the class.

The two weakest areas in this presentation were the introduction and the manner in which the teacher answered student questions. Although the teacher did review the chemistry content before starting the actual demonstration the students were confused at first about the purpose of the demonstration. The teacher did have a fairly strong background in chemistry, but still had trouble answering student questions.

Teacher Number 21: Demonstration 1.

Presented in this demonstration were three chemical tests to compare important properties of motor oil. The objectives of the demonstration were to teach the prospective teachers in the micro-class how they might effectively use these tests.

The weak points of this demonstration were the questions the teacher asked and the manner in which he answered student questions. It appeared that the teacher had not prepared specific questions but had relied entirely on miscellaneous questions thought of during the presentation. The teacher did not know the answers to some questions asked by the students and was very evasive in answering others. The teacher was not familiar with the chemical reactions used in the test, a factor which undoubtedly contributed to his reluctance to answer questions.

The demonstration was a popular one with the micro-classes possibly because of the personal experience the students had had buying motor oil. However, the investigator doubts that the micro-classes learned anything from the demonstration beyond the basic steps in performing the tests.

Teacher Number 21: Demonstration 2.

This demonstration was very similar to the first. The objective was to teach the students how to conduct simple chemical tests for harmful bacteria in drinking water.

The weak points of this demonstration seemed to be caused by the teacher's lack of knowledge of the basic chemical reactions involved in the tests. Early in the first trial the teacher could not answer a question about the reactions. This seemed to have a very detrimental effect on the way the teacher asked and answered questions for the duration of trial one.

Although the teacher had regained his composure and was somewhat better organized during the second trial, he still had trouble answering student questions.

This demonstration was also very popular with the students in the micro-classes. After the completion of each trial it was necessary to remind the micro-class that their function was to critique the presentation, not to prolong the discussion.

Teacher Number 22: Demonstration 1.

An ammonia fountain was used in this demonstration to show how rapidly some gases are absorbed in water. At the completion of the presentation the students were to be able to explain principles involved in the operation of the fountain.

The weak points of the presentation were the introduction and the handling of questions. At the beginning of the presentation the micro-class was uncertain of the objectives of the demonstration, and the questions asked by the teacher did not seem to lead them in the right direction.

Among the strong points of the presentation were the teacher's enthusiasm, his knowledge of the science content, and the ease with which he manipulated the apparatus. In spite of his apparent knowledge of the subject, however, he did have trouble interpreting and answering student questions.

During the second trial of this demonstration the problems involving questions and answers were reduced but a new problem arose.

As the teacher concentrated more on the questions asked and the answers he gave, the pace of the presentation slowed to a rate at which the students in the micro-class became restless. This factor reduced the effectiveness of the presentation.

Teacher Number 22: Demonstration 2.

Chemical equilibrium was the topic of the second demonstration presented by this teacher. At the completion of the demonstration the students were to be able to explain LeChatelier's principle in relation to equilibrium. Several simple chemical reactions involving color changes were utilized in the demonstration.

There was some improvement in the categories involving questions, and the introduction was much stronger than in the first demonstration. This demonstration worked better than the first, and as a result there was a definite feeling of increased confidence on the part of the teacher.

On the second trial the micro-class gave the teacher a much lower rating on the way he answered student questions. It is the opinion of the investigator that the questions asked by the students during the second trial were more vague and ambiguous than those asked during the first trial.

Teacher Number 23: Demonstration 1.

The purpose of this demonstration was to show the students in the micro-class how to construct and use a piece of apparatus used in the Chemical Bond Approach secondary school chemistry course. Specifically the demonstration was designed to show the effect of an electric field on ions separated by an agar block.

The weak points of the first trial were the introduction and the questions the teacher asked. Actually, there was no introduction and the teacher asked very few questions. As a result the students did not understand the purpose of the demonstration when it was completed.

The apparatus used in the demonstration did not work well. Although this appeared to be more a fault of the directions used in constructing it than a fault of the teacher, the students were confused.

During the second trial there was improvement in the questions the teacher asked. The teacher did attempt to introduce the demonstration by reviewing the chemical principles involved. This introduction was not very successful. The rating on the way the teacher answered student questions remained low during the second trial.

Teacher Number 23: Demonstration 2.

The second demonstration by this teacher was also a CBA demonstration. The purpose of the demonstration was to teach the students how to construct and use a standard cell. The teacher had constructed the cell before class, therefore the greater part of the time was devoted to showing the students how to use it.

The weak point of the presentation was that the teacher did not understand the physics principles involved. He could not explain the electrical circuit used and was unable to develop the concept of a potential. The students composing the micro-class for the second trial had even less background in physics and, as a result, they understood the operation of the apparatus less than the first trial micro-class.

The demonstration seemed to be very interesting to the class, possibly because it was one of their first contacts with CBA materials. Unfortunately, the presentation did not achieve the stated objectives.

Teacher Number 24: Demonstration 1.

The topic of this demonstration was strong versus weak electrolytes. An electrical circuit including a light bulb was used to test the unknown solutions for conductivity. The objectives were to teach the students the chemical principles involved and how to safely present the demonstration.

The weak points of the presentation were the lack of an adequate introduction and the way the teacher answered student questions. The teacher tried unsuccessfully to lead the students into answering their own questions.

The teacher had a strong background in physics and chemistry. He had constructed the apparatus so that is would be relatively safe for use by either the teacher of a secondary school science class or by the secondary students themselves. During the presentation the teacher did suggest that some of the student questions could be answered by student projects or laboratory experiments.

Teacher Number 24: Demonstration 2.

The second demonstration was designed to show how electrical energy is changed to sound energy in speakers. Both permanent magnet

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and electromagnet speakers were utilized to show the difference between the old and the new. As one of the objectives of the presentation the students were to be able to discuss the shock hazard of electromagnet speakers. In addition, they were to be able to explain the frequency responses of different size speakers.

As an introduction the teacher asked the students how many speakers each had where he lived. Although the objectives of the demonstration were not immediately obvious, the introductory question did arouse the interest of the classes.

The weak points of the presentation were the questions the teacher asked and the failure of the students to understand the objectives at the completion of the demonstration.

During the second trial there was improvement in both of these areas. The second micro-class seemed to understand the questions better, and the teacher made a special effort to clarify the objectives of the demonstration.

Teacher Number 51: Demonstration 1.

The topic of this demonstration was a chemical test for vitamin C. Several fruit juices were tested to teach the micro-class the technique and the chemical principles involved.

The three weak areas were the introduction, the questions the teacher asked, and the way he answered student questions. The only introduction was a statement made by the teacher that: "The demonstration I am going to do today is . . ." The questions the teacher asked were very vague and most of his answers were the same.

The strong point of the demonstration was the simplicity of the chemical tests. Although the majority of the students were familiar with the test for ascorbic acid, none of them had seen it used to test for vitamin C.

Teacher Number 51: Demonstration 2.

For this presentation the teacher constructed a DNA molecule which could be used to demonstrate self duplication of DNA or the formation of the RNA molecule. The objectives of the demonstration were to show the students how to construct the models and how to use them in teaching.

The weakest areas of the presentation were the introduction and the questions the teacher asked. During the second trial the introduction remained a weak area, but there was some improvement in teacher questions. At the same time, however, the teacher had much more trouble answering student questions.

One of the strong areas in both trials was the ease with which the teacher manipulated the model. The teacher had used velcro on the parts to be joined and separated during the demonstration and it worked very well.

Teacher Number 52: Demonstration1.

The process of starch digestion in man was the topic of this demonstration. Processes demonstrated were the action of saliva on starch and the relative permeability of intestinal membranes to starch and sugar.

It was necessary that part of the demonstration be set up before class time. Because the teacher had not recorded the time he had placed the membranes containing the starch and sugar solutions in the distilled water, he could not answer several student questions. The introductions to both trials of this demonstration were very weak.

The teacher was able to develop a fairly good discussion during both trials of the demonstration.

Teacher Number 52: Demonstration 2.

Diffusion was the topic of the second demonstration. The demonstration progressed from the diffusion of a gas in air to the diffusion of a dye in a liquid. The objective of the presentation was to help the students develop a comprehensive concept of diffusion of any substance in any media.

The micro-classes gave very low ratings to the introductions of both trials of the demonstration. The teacher had opened a bottle of a volatile liquid before the students entered the room for the first trial. When this was not successful in arousing interest, the teacher tried to improve the introduction by using a much stronger odor the second trial. This time the odor was too strong and the micro-class again gave him a low rating.

The teacher had not planned specific questions to help develop the concept of diffusion. He had trouble answering student questions and, as a result, received low ratings in both of these areas.

Teacher Number 53: Demonstration 1.

The objectives of this demonstration were to teach the students how to collect, concentrate, and observe a protozoan culture. Using materials supplied by the teacher, the students prepared sample slides. Preparation of the slides included staining with one or more stains.

The weak areas of the presentation were the introduction and the questions the teacher asked. All the other areas on the evaluation forms were rated uniformly high. The teacher had very carefully prepared the demonstration. He prepared slides very skillfully and watched the reactions of the class as he worked to determine if the pace was too slow or too fast. The teacher answered student questions very well. Overall the presentation received a relatively high rating.

During the second trial of this demonstration both the introduction and the area of teacher questions were improved. At the same time, however, other areas received slightly lower ratings, and the second trial was rated lower than the first.

Teacher Number 53: Demonstration 2.

This demonstration was planned to teach the students how to key aquatic and terrestrial snails. Although this presentation concentrated on snails, keying in general was the overall topic. Working with several varieties of snails, the teacher guided the students through a complete keying exercise.

There were no definitely weak areas in this presentation. The teacher had developed a fairly strong introduction and had included some very good questions in his lesson plan. The students seemed to enjoy taking part in the demonstration. Keying snails was a new experience for a majority of them.

The second trial was rated slightly higher than the first. The teacher was more sure of himself, and the presentation was paced better than the first.

Teacher Number 81: Demonstration 1.

The effects of the unusual freezing characteristics of water on awuatic plants and animals was the topic of this demonstration. The objectives of the demonstration were to teach the students what occurs as water cools first to the maximum density point, and then to the freezing point. The students were to be able to discuss what happens to aquatic life during this process and what would happen if ice sank instead of floating.

Very little apparatus was involved. The teacher had an aquarium containing fish and plants, with ice cubes floating on the water. The teacher had also prepared charts to show the density of water at different temperature. Most of the presentation was devoted to the physical science concepts. When the teacher finally got to the biological science applications the students were confused about how much of the preceding time had been devoted to the introduction.

The teacher asked some very good questions during the presentation but was not rated well on the way he answered student questions. Most of the student questions were related to the physical properties of water. Neither the class nor the teacher was sure of the correct answers.

During the second trial the introduction was improved and the teacher was more careful in answering student questions.

Teacher Number 81: Demonstration 2.

The general topic of the second demonstration was muscle fatigue. The students were to be able to explain muscle fatigue in relation to the chemical reactions which occur when muscles are used. Immediate and long range effects were included. The only apparatus used was a weight which one of the students held at arm's length, shoulder high, while the teacher led a discussion about what was happening.

The pace of the first trial was much too slow for the microclass. The students also gave a very low rating to the questions the teacher asked.

During the second trial the teacher paid more attention to student reactions and the pacing improved. The teacher asked approximately the same questions, but attempted to make sure the students understood them before he expected an answer. Overall, the second trial was rated higher than the first.

Teacher Number 82: Demonstration 1.

This demonstration was developed to teach the students how to use a microtome and how to prepare temporary slides with the resulting stem sections. The teacher demonstrated three different microtomes to the class. The students then sliced sections from stems prepared before class, mounted the sections on slides, and viewed them with a micro-projector. Sections of different thickness were made to illustrate the importance of thin sections.

The area of teacher questions received the lowest rating on the first trial. He did allow the students to ask questions, and he answered them very well. The introduction received a fairly high rating and, in general, the demonstration was well done.

During the second trial the teacher paid more attention to asking questions, and this area received a higher rating. Unfortunately other areas, including the way the teacher answered questions, suffered. The second trial received a lower average rating than the first.

Teacher Number 82: Demonstration 2.

The objectives of the second demonstration by this teacher were to teach the students the chemical processes of electrophoresis, their effects on the migration of proteins, and how the process is used in the analysis of blood.

There were no specific weak areas in either trial of this demonstration. The demonstration had been well planned. The presentation went very smoothly, utilizing blood samples donated by the teacher. The areas of both teacher questions and student questions received relatively high ratings. The introduction was rated above average. In general, it was a very successful presentation.

APPENDIX I

ANALYSIS OF COVARIANCE TABLE

ANALYSIS OF COVARIANCE TABLE

Source	DF	YY	Sum-Squares (Due)	Sum-Squares (About)	DF	Mean-Square
Treatment (Between)	2	160.1172				
Error (Within)	27	633.8965	117.9318	515.9646	24	21.4985
Treatment +Error (Total)	29	794.0137	123.3889	670.6247	26	
Difference for testing adjusted treatment means				154.6601	2	77.3300

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